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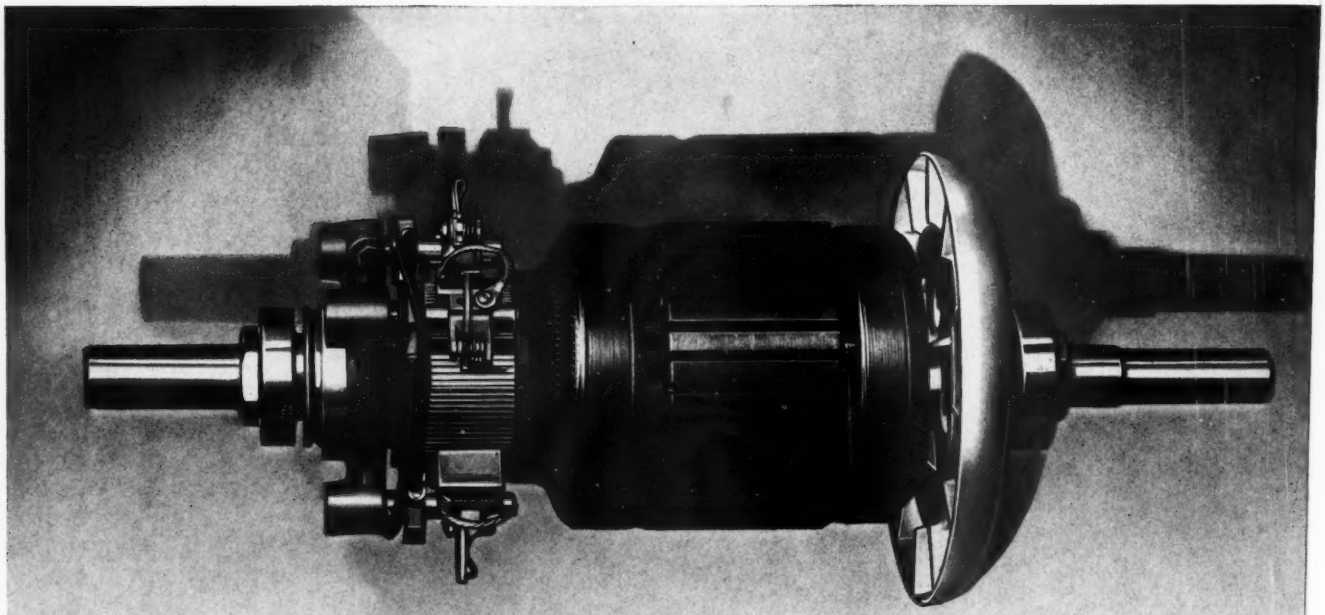

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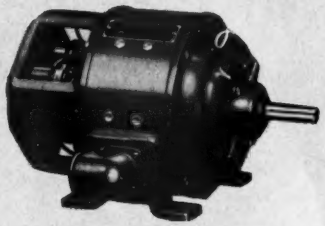

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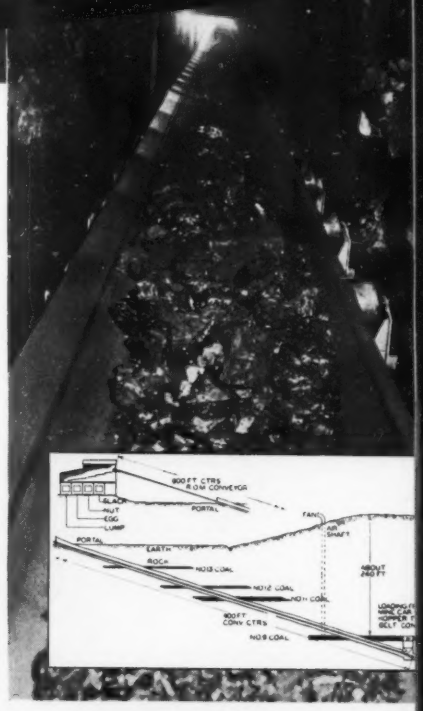

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MINING CONGRESS JOURNAL

Vol. 28 JANUARY, 1942 No. 1

The past year has been as momentous for the mining industry as it has for the whole nation. The industry, in speeding up delivery of the raw materials so vital in a "war of machines," has assumed the duty of supplying, without stint, all the production of which it is capable.

The new year is ushered in with the country at war on many fronts. All that has gone before has been merely preparation; now, in answer to the President's call for double and quadruple production, the mining industry pledges itself anew to see that our armed forces and the industrial front are supplied in ever-increasing amounts with the metals and the power with which victory will be achieved.

Journal articles this month deal with several phases of this battle of production, and with the economy of the post-war world. Attention is directed to the symposium on Ore Discovery, in which some of our most eminent geologists analyze the factors leading to ore discoveries of recent years, in order that the lessons may be applied to present and future ore search.

NEXT MONTH, our Annual Review issue. Brief articles reviewing the accomplishments of the past year, and outlook for the future, in the fields of each of the major metals, non-metallic and coal.

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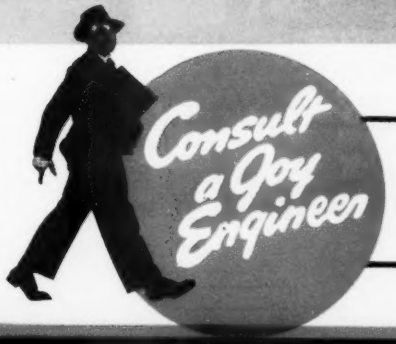

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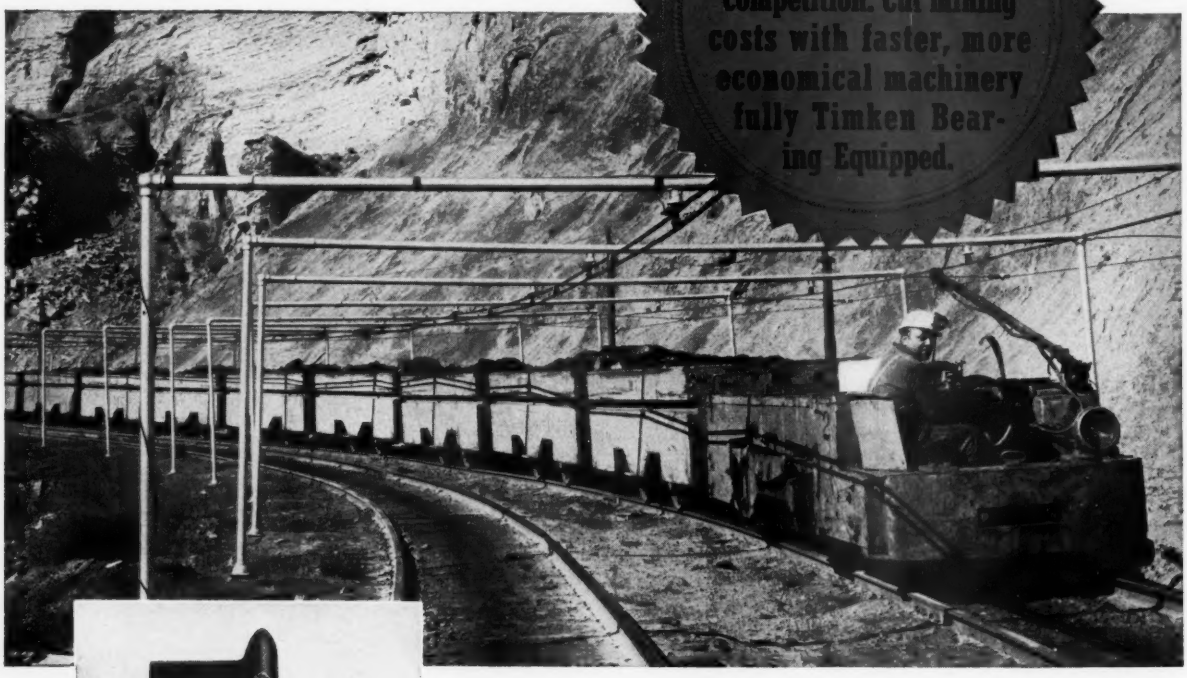

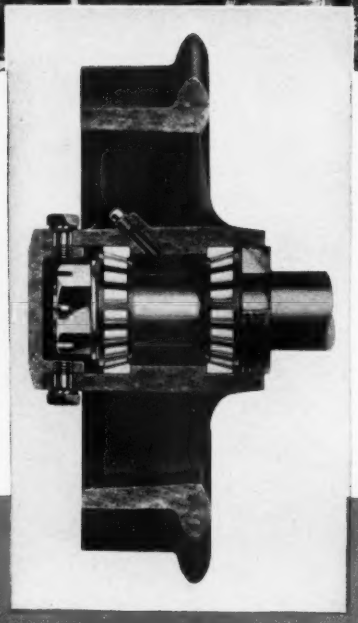

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A JOURNAL FOR THE ENTIRE MINING INDUSTRY—PUBLISHED BY THE AMERICAN MINNG CONGRESS

MINING CONGRESS JOURNAL

Vol. 28 JANUARY, 1942 No. 1

EXCESS PROFITS OF MINES

THERE has been a natural and proper feeling that first the defense and now the war needs of the Government should not be occasion for making excessive profits from emergency needs. Under the variant and uncertain conditions of many different kinds and conditions of business units in the great body of industry, it is impossible to establish price-fixing policies, contract provisions or other measures which will be uniformly applicable to prevent or limit excessive profits in every possible case. Prices which to one organization or under certain conditions may yield inadequate profits or even losses may for another organization or under different conditions yield great profits.

One of the measures adopted to meet this situation is the excess profits tax. The principle of such a tax—to discourage the making of excessive profits, or to recapture excessive profits if made—seems to meet general approval. The difficulty, recognized in theory and evidenced in practice, is to find the fair measures for determining excessive profits to which such a tax should be applied.

Considering excessive profits as being profits realized in excess of a fair return on the value of the assets employed in the business, the risks involved, and the experience, ability and energy required, we find no single standard an adequate measure to be uniformly applied to all business enterprises. Our present law endeavors to meet the situation by alternative allowances based either on invested capital or on prior earnings, supplemented by special provisions for relief in some abnormal situations. Granted that any tax law at high rates unavoidably works some injustices, nevertheless if we find that any tax law does or will apply unjustly to an entire industry or a substantial part of the industry, we are justified in asking for fair modification of its provisions.

There can be no question that the present excess profits tax law does work out very unfairly to many in the mining industry. The prescribed rates of 7 or 8 percent of invested capital (which under the present law become effective rates of 4.9 or 5.6 percent after deducting a 30 percent income tax) are wholly inadequate to measure a fair return in the mining industry. Most mines do not have an adequate invested capital as that is defined in the present law, because in most cases the law makes no allowance for the developed value of the mining property. Few, if any, mines have a fair average earnings showing for the four base period years prescribed by the statute, since these as a whole were years of particularly adverse conditions in the mining industry. If it were the intention that no mine should do substantially better in scale of operations or amount of profits than its average for the four years 1936 to 1939, or that no mine should operate on a scale which would yield it more than approximately 5 percent net on its capital, the present law might be justified as planned to bring about that result by imposing taxes which may run to 72 percent on any increased earnings above such a standard. It could be considered that the Government was by this law saying that it wanted the mining industry to confine itself within such a scale, subject to the heavy penalties of this tax if it made profits in excess of the prescribed standard.

Such a penalty is exceedingly serious in the mining industry where the amount realized from operations in any year comes only from exhaustion of resources. Other industries may expect to continue year after year with the consumption of goods in one year in no wise limiting its ability to obtain the needed raw materials for its operations in future years. The purchase by a manufacturer of steel or other materials consumed in his operations during the emergency period is not expected to limit in any way his ability to obtain the needed raw materials for conduct of his business after the emergency is over. This is not so with mines because what they consume in their raw materials during the emergency limits by just that much the supply of raw materials available from each particular mine in the years after the emergency is over. Thus, a penalty tax which may take as much as 72 percent of the profits which would normally be realized from disposal of its mineral products is virtually equivalent to notice to the mines that they should not operate on such a scale as will subject them to this penalty.

This is not criticism of the application of the excess profits tax to the extent that any mine may actually be making excess profits on its production. Price increases necessary to bring out maximum marginal production may result in a high profit margin to low-cost mines. Increased volume of production may in some cases and within certain limits give reductions in cost which will mean a larger profit margin, but in other cases or under other conditions increase in volume of output can only be obtained by increased costs and a resulting lower margin of profit. On the other hand, increased wage scales or other cost factors may counteract the effect of increase in prices for product or increases in volume of production. If in any particular case it is a fact that a mine is making more than normal profits on its production, there is no protest against the application of the excess profits tax, nor is there protest against the application of the income tax to any real profits, whether more or less than normal, by a mining company.

The particular feature in the mining industry is that the amount of profit realized in a particular year is not evidence that the mine is realizing an excess profit on its production. If all that happens is that a mine merely realizes in one year the profit which normally it would expect to realize over a longer period, it is not making excess profits. If the normal profit for a particular mine were $1.00 a ton for its product (or a certain amount per pound) it is not making excessive profits because it realizes this amount in one particular year instead of in another. The mine which contains 500,000 tons of ore which would normally yield it $1.00 a ton of profit, extracted at a normal rate of 100,000 tons a year over five years, is not in fact making excess profits it it mines out its 500,000 tons in three years but still makes only $1.00 per ton profit. If it mines 150,000 tons in a year, instead of mining 100,000 tons at the same $1.00 a ton rate of profit, it has only realized a normal profit. The additional $50,000 realized in that year is not in fact excess profits. Only if the mine were realizing more than a normal profit per unit of output should it be considered that the mine is making an excess profit.

As stated above, if it were the Government's intention to discourage mines from producing more in any year than a normal output, or an amount which would yield more than a prescribed normal profit for that year, the present excess profits tax law might be considered a proper medium for enforcing that purpose. However, we know that is not the present intention. The Government is urging maximum possible output from the mines to relieve the present bottle-neck in the entire war program. The mining industry is endeavoring to meet that need, and intends to do so, even though a penalty tax is imposed upon it for so doing.

The amendment to allow an excess profits credit based on unit of production which Senator Johnson of Colorado proposed to the Revenue Act of 1941 would relieve this situation where the mining companies are on the one hand being urged to increase production but on the other hand are apt to be penalized if they do.

This subject was recently presented before the special Senate committee investigating the national defense program, of which Senator Truman is chairman, through an appearance by Neil W. Rice, president of the U. S. Smelting, Refining and Mining Company, and Henry B. Fernald, chairman of the Tax Committee of the American Mining Congress, in which Senator Johnson discussed further the testimony presented by these witnesses.

In the course of the discussion Senator Herring, a member of this committee who is also a member of the Finance Committee, referred to Senator Johnson's amendment as one of those which was left to be taken up in an administrative bill, stating: "We left many of these inequalities in the present tax bill, and if that (the administrative bill) is passed, it is our understanding that it will be retroactive and protect those who are now being penalized by what you consider an unjust provision." Chairman Truman stated:

"I was sure of that. We have never wilfully inflicted an injustice on anybody. We need metals now, and I am trying to urge you gentlemen, tax or no tax, to do something about it. . . ."; and later: "You have been working under a psychological injustice which the Senator from Iowa said was going to be corrected. Forget that and let's get that corrected"; and again: ". . . I think you are going to get justice on that when the tax committees meet; I think that is going to be out of the picture."

Senator Truman asked us to believe the injustice would be remedied and to urge the mining industry to go ahead in that belief, devoting all its energies to give the maximum possible output of needed mineral production.

This editorial is intended to carry that message to the mining industry.

Filling Mine Stopes With Mill Tailings

By C. W. PLUMB
General Manager
Middle Fork Gold Mining Company

The use of mill tailings for stope fill has in several places, notably at Homestake mine, been proven to have real advantages, not the least of which is a lesser cost than other methods of filling stopes. For those who may be contemplating this method, Mr. Plumb gives an excellent account of the equipment and means employed at the Sliger mine, and some of the precautions that must be observed.

THE Sliger Mine is located about eight miles from Georgetown, Eldorado County, Calif. The mine is operated by the Middle Fork Gold Mining Company, a subsidiary of the International Minerals and Metals Company.

The Sliger vein, as mined, is quite wide, the stopes varying in width from 25 to 50 feet. The vein is extremely hard, strikes north and south and has a dip to the east of approximately 60 degrees. Overlying the vein, as a hanging wall, is a 100-ft. thickness of a very soft serpentine gouge. Stoping is carried on by cut and fill. Stopes are carried from 12 to 14 ft. in height, with round stulls placed as necessary. Cribbed chutes are placed at strategic positions for handling the broken ore. Formerly these chutes were constructed of round timbers and the inside was lined with 2-in. x 12-in. B. C. lumber, but due to the excessive repair work required, because of the very hard, sharp-edged broken ore, we have recently constructed the chutes of short blocks of 6-in. x 6-in. lumber, varying in length from 2 ft. on down to 1 ft., as the stope advances in height. The blocks are so placed that the broken ore, in falling through the chutes, strikes the end of the blocks, instead of the sides, similar to the blocks in the old hydraulic tail races; this has practically eliminated all repair work on the chutes.

Prior to the use of mill tailings for filling stopes, we were forced to go into the footwall and mine waste for filling. This was most expensive, as it cost more for filling than it did to mine the ore. We therefore decided to look into the possibilities of mill tailings for stope fill. In 1939 our general superintendent, E. H. Syms, and myself, paid a visit to the Homestake mine at Lead, S. Dak., to look over their method of sand filling. Alex Ross, formerly general superintendent at the mine, personally explained and showed us every detail of their operation, both underground and on the surface. Following this visit, we immediately started construction of our own "sand plant." It has been in continuous operation since March, 1940, and has eliminated all necessity for mining waste for stope fill.

Operation of the Sand Plant

We are milling approximately 200 tons per 24 hours. To take care of the tailings we installed two redwood tanks; each tank will hold a 24-hour run of the mill. While one tank is being filled with a day's run of tailings, the other is being emptied and the tailings are being sent into the mine. The accompanying sketch will show the set-up.

Each tank is equipped with a regular cyanide sand leaching tank valve, in the center of the bottom, and the valve is controlled by a hand lever from the top of the tank. Following down alongside the lever rod from the top of the tank to a point near the valve itself is a one-inch water pipe, perforated with small holes, for spraying purposes. Also around the periphery of the tank on the inside near the top are other sprays. All of these sprays are for the purpose of keeping the pulp in motion and helping to control the density, when the tank is being emptied. As density control is the main factor in the successful operation of the tank, the less the amount of water used for these sprays, the better. We have found that, as a tank is being drawn, the pulp from the side slides toward the center of the tank in varying amounts, sometimes in such large quantities as temporarily to slacken the flow from the tank. In these instances the water from the sprays builds up above the pulp and when it breaks through, it goes in a rush and materially lessens the density of the pulp. To overcome this, we installed another small pipe, perforated, at a point near the outlet valve, and use a small amount of compressed air. This air keeps the pulp in motion when one of the rushes occur and has eliminated abrupt changes in density.

When the pulp is started toward the mine it flows through a launder below the outlet valve, into an agitator tank, where any lumps are broken up and where extra water valves are placed, so an absolute control of the density can be maintained. There are no operators on hand during the filling of the tanks, but when emptying a tank, one operator is stationed there to control the flow and density, maintaining a density of from 65 percent to 70 percent solids for the pulp flowing into the mine.

Introduced also at the agitator tank, as the pulp goes into the mine, is a small amount of aluminum sulphate (about 25 pounds per 200 tons of pulp). This is for the purpose of settling the colloidal material from the pulp as it is deposited in the stopes and for obtaining as clear an overflow as possible, as the water goes to the sump for pumping back to the surface. We found aluminum sulphate to be far better than lime as a settling medium in our tailings.

As the tailings comes from the mill to the storage tanks above noted, it drops into a distributing box, from which it is distributed to all parts of the tank, through eight 2-in. pipes, attached fan-like to the box. This is for the purpose of getting as good a mixture of the pulp as possible in the tanks. We originally used a de-sliming cone above the tank, but abandoned it and now let only the slime that overflows from the top of the tank go to the surface tailings pond. We found that sand with a fair amount of slime

made a much better fill and was easier to handle in the pipes and hose. Sand, alone, is almost impossible to handle for filling in our method.

At the present time we are returning about 85 percent of our total mill tailings to the stopes for fill. The following screen analysis will show the various size of the mill tailings and of the pulp sent to the stopes.

	Tailing to Storage Tank	Tailing to Mine Stopes
	+ 80 mesh— 0.0%	0.0%
— 80	+100 mesh— 1.0%	2.0%
—100	+150 mesh—18.0%	24.0%
—150	+200 mesh—15.0%	22.0%
	—200 mesh—66.0%	52.0%

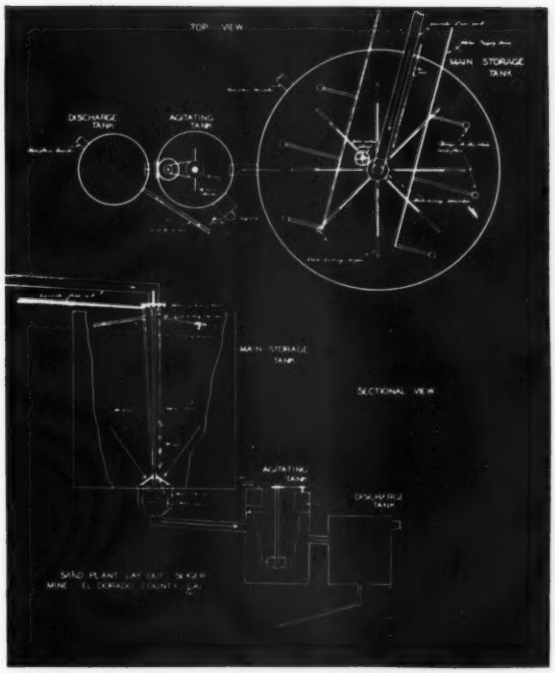
Pulp Flows to Stopes

From the discharge of the agitator tank, and after density is controlled, the pulp flows by gravity through a 2-in. line to the various stopes in the mine. We originally installed standard 2-in. pipe, but used a rubber hose of 2-in. diameter. The hose was constructed like a suction hose, having wrapped wire re-enforcing, and also having an inside lining of live rubber ¼-in. thick. About 75,000 tons have passed through this hose and so far it shows no appreciable wear. We plan on giving it a quarter turn every year to maintain an even wear on the rubber. There are no valves, or other encumberances, on the line from top to bottom. The rubber hose is used as a main line from the collar to the bottom of the shaft. At the various working levels, and when a stope is to be filled, a curved piece of standard 2-in. pipe is attached to the main hose line and the pulp diverted to that level. Any old 2-in. standard pipe is used on the levels, from the main hose line to the stopes.

It was on recommendation of Mr. Ross that we tried the 2-in. pipe. The experience at Homestake, where they were handling 4,000 tons per day and had installed a 6-in. pipe for a main feed line to the mine, indicated that this was entirely too large, and the lack of keeping the line filled with pulp caused a great deal of trouble, due to air pockets, vacuums, etc. We find we can flow about 50 tons per hour through our 2-in. line and have had no trouble with it. Our present sand line goes to our 1,400 level. We have never developed any pressure trouble because of the pulp in the hose.

It Is Not Necessary That Lines Have Favorable Gradient

It is probably better to install the auxiliary lines on the various working levels on a down grade to the stopes, but we find this is really unnecessary, as some of our lines actually have a slight up grade. As a matter of fact, we have successfully filled a stope above a level by lifting the pulp to an elevation of 25 ft. above the feed line on the level. Mr. Ross informed us they had filled their square sets to an elevation of 80 ft. above a level. One's first thought is that as soon as the flow of pulp stops, the flat pipe on the level will fill with pulp, and solidify. It has never done this for us.



Lay-out of the sand plant, described in this article

The successful operation is as follows: The first thing to do before starting the flow of pulp from the storage tank is to fill the feed line entirely with water, to eliminate all air and voids in the line. Next start the flow from the surge tank near the agitator, to the respective stopes to be filled. The pulp is distributed around the stope through a flexible hose fitted with a nozzle, similar to a fire hose. The pipe and hose line must never be permitted to take air from the top. The size of the discharge nozzle enables one to control the flow so that the pipe line is kept full. When the storage tank at the surface is emptied of pulp, clear water is permitted to flow through the pipe or hose for several minutes. This washes the line free of pulp, so that even the pipes laid on a flat, or up-grade are open and free for subsequent use. Of course, no air must be permitted to enter the top of the feed pipe, while changing from pulp to clear water. We originally fed clear water for five minutes or more, but we find that about three minutes is ample for cleaning the line. The less clear water permitted to go into the mine means that much less to be pumped out.

Stopes Prepared for Sand Fill

As stated above, the Sliger stopes vary from 25 ft. to 50 ft. in width. Cribbed chutes lined inside with 2-in. x 12-in. lumber were used for handling the ore. When preparing for a sand fill, these chutes were lined on the outside with a cheap 1 in. x 8 in. ship lap to make them watertight. A vertical strip, about 4 in. wide, was left open to take care of the overflow water from the top of the fill. As the pulp rises in the stope, narrow pieces of ship lap are placed horizontally across this narrow opening, to raise the overflow level. The overflow water is permitted to flow down the chute to the sump on the level below; the use of the aluminum sulphate for settling gives an almost clear overflow. Homestake was using burlap for waterproofing the chutes, while we were there, but as it was very expensive, Mr. Ross suggested we try the ship lap, and we have used it successfully ever since we started operation of the sand filling. The use of 6 in. by 6 in. blocks in the chutes has eliminated entirely the use of ship

lap for waterproofing, as the blocks themselves make a watertight seal. To take care of the overflow water from the fill we knock out one of the blocks at the lower end of the chute and construct a small three-sided box, or periscope, as we call it, vertically alongside the block chute. As the fill rises, a narrow piece of ship lap is added to the open side of the periscope, raising the overflow in a similar manner to that used on the cribbed chutes.

We raise our stopes about nine ft. with each successive lift so, consequently, chutes are raised that distance just before the filling starts. When an area is ready for filling and the chutes are raised to the required height, a board dam is constructed of the 1 in. by 8 in. ship lap to the same height, to keep the sand from flowing on to the working stope just ahead of it. Three men only take care of the sand filling process. They prepare the stope for filling and when it is ready, one man goes to the surface to operate the sand plant. Another handles the hose for distributing the pulp, while the third watches the stope for possible leaks. This third man has old sacks ready for stuffing up any small leaks that may develop. In direct contrast to what most people think who have not seen the process, the fill is not a pulpy, moving mass, but is firm and substantial. The hose man and the man watching for leaks are walking over it all the time, while the pulp is being distributed. As a matter of fact, when a stope is entirely filled to the top of the ship lap dam—after two or three days time—the ship lap is removed for future use and the face of the sand fill stands firmly.

Sand Filling with Tailings Has Many Advantages

We feel we have derived many benefits from the use of sand filling; the prime one is, of course, lesser cost for filling. When we were breaking footwall material it required 20 men, or more, to supply the fill; now we use three men only.

Second, the fill forms a tight seal against the hanging wall and there is no give to the hanging wall, as was the case in the use of rock fill. With no give to the hanging wall, there is no resultant pushing and breaking of the timbers in the stopes, hence there is practically no repair work to the timbers.

Third, the fill eliminates immediately any short-circuiting of air, as is the case with a broken rock fill. Air currents must pass through the raises, where they can be controlled.

Fourth, the fill has permitted us to stope up under a level and take out 100 per cent of the ore in the sills and pillars, without the least additional pressure or fall of rock from the hanging wall. This is the first time we have seen this done, without expensive timbering cost. The application has many possibilities in this phase of a mining operation. After the ore is extracted from sill and pillars, the opening is filled solid with the sand fill and the ground is apparently as firmly in place as it was before the stoping was done.

Fifth, by using 85 percent, or any appreciable percentage of mill tailings for the stope fill, a great advance toward the elimination of the pollution of streams has been made. This does not entirely cure the tailings dam problem, but it at least reduces the size of a pond. One's thought is that the slimes overflowing from the storage tank and going to a tailings pond are almost impossible to hold. Experience shows, however, that by careful work an excellent pond can be made from the slimes themselves.

One may feel that we are unduly enthusiastic about the use of mill tailings for filling, but our experience at the Sliger has made us so. Our experience so far has been only in the "cut and fill" stopes, but we can see the possibilities of its use in several methods of stoping, such as the filling of shrinkage stopes, square sets, rill stoping and many others; also the possibility of controlled sand filling in fighting mine fires, is worthy of investigation.

Precautions Must Be Observed

One contemplating the use of sand for filling would be very wise to see and study the details of the operation, before attempting it. For instance, the start of the first sand fill, in a stope that is partly filled with broken waste, is most important and requires careful control. The density of the pulp should be as great as will possibly flow through the pipes for this first covering. Also it is probably true that all tailings are not suitable for fill, due to an excessive amount of slimes. However, one will note that the screen tests show the material sent to our stopes is very fine. We believe it would be well for anyone planning on using the tailings for fill to try it out thoroughly on the surface, as we did, before going to the expense of constructing a plant.

Growing Gold

Weeds and other vegetable growths have long been recognized as of value to geologists in places where the character of the growth enable them to differentiate different types of terrain or underlying strata. But through the *Western Mining News* a more ambitious and possibly more directly remunerative use of vegetable growth in mining is reported. The News reports that Dr. Hans T. F. Lundberg, a geophysicist of Toronto, Canada, has discovered that certain plants growing over ore bodies extract metal from the ground, and that the common horsetail weed which grows in abundance in certain swampy areas is the best agency yet discovered for the purpose. Dr. Lundberg offers the suggestion that in areas where the gold deposit is too low grade to mine, it might be possible to plant the horsetail weed and then collect and burn the plants to obtain the gold content. He reports a gold value of four and one-half ounces to the ton of weed.

That sounds visionary, but it might be worth a try. If four and one-half ounces can be obtained per ton of weed, there are many places in this country where the planting and harvesting of horsetail would be a profitable occupation.

Copper Products Plant Building

The Phelps Dodge Copper Products Corporation, a wholly owned subsidiary of Phelps Dodge Corporation, has started the erection of a plant at an estimated cost of approximately $3,000,000, for the manufacture of copper products, at Los Angeles, Calif. It is reported that the plant will be used in the manufacture of copper wire and cable, seamless brass and copper tubes, copper strip and rods.

Alaskan Reunion

A reunion was held in Fairbanks, Alaska, recently of early residents and later arrivals at the famous Rampart gold camp, which was discovered in 1896 by John Minook. Four of those present had arrived in the district more than 40 years ago, and they recalled the fact that Rampart at one time had a population of about 1,500 people. Included among the citizens at various times were the writer Rex Beach, and Tex Rickard, who later became famous as a boxing promoter.

Corporation Changes Name

International Agricultural Corporation, producers of phosphate, potash, fertilizers and chemicals, with offices in Chicago, changed its corporate name, effective December 1, to International Minerals and Chemical Corporation.

ALLAYING COAL DUST at Island Creek Coal Company Mines*

By J. A. SAXE
Chief Engineer

The most important place to attack the problem of dust in mine air is at the face, where most of the dust is produced. Reducing or eliminating dust at the face serves two purposes: explosion hazards are reduced and a healthier, safer place to work is provided.

The Island Creek Coal Company has proved by experience that these results can be accomplished at a justifiable cost and with no injurious effects on subsequent preparation of the coal. Every coal mining man will be interested in reading this account of the company's experience.

PRIMARILY the purpose of this paper is to make the statement that in coal mines 90 percent of the dust can be eliminated at the working face at a justifiable cost and with no resultant injurious effect on fine screening, air cleaning or other methods of preparation. The statement that 90 percent of the dust can be eliminated at the working face is based on dust counts taken on our dustiest sections by the Bureau of Mines. For the balance of the statement that the cost is justifiable and that preparation is not injuriously affected, we are responsible.

To say that we reduce our dust concentration 90 percent is somewhat vague. By actual test we have determined that our driest and dustiest places have concentrations of dust up to 360,000,000 particles per cu. ft., and for various face operations an average from 87,000,000 to 246,000,000 particles per cu. ft. We find we reduce an average concentration of 300,000,000 to 30,000,000 particles per cu. ft. Generally, samples taken at the positions occupied by our face and boom men average 20,000,000 particles per cu. ft. We also think we can improve our present methods, particularly where we have heavy concentrations. Note that the above statement refers to averages. We do have occasional surges of dust that break through our spray streams. These surges do get past the face but are under the average a short distance down the room before reaching the rock-dusted area. The effect of continued spraying and good ventilation is quite marked under this condition.

For technical data on dust allaying we can recommend Bureau of Mines Technical Paper 593. Further data on wetting agents, nozzles, spray arrangements, etc., can be found in Information Circular 7131 and the Second Report by the Coal Dust Research Committee of the Monmouthshire and South Wales Coal Owners Association.

We would like to acknowledge the practical, helpful services we have had from the Bureau of Mines that contributed to the solution of this and other problems. The cooperation and technical services of Messrs. Harrington, Forbes, Greenwald, Johnson, Fene and Maize is especially acknowledged.

Sprays Used on Dust-Producing Equipment

The method used is an arrangement of sprays on our dust-producing equipment that will inject water, with a wetting agent, in an envelope enclosing the dust-producing area. We attack the dust in suspension and do not attempt to wet the coal and prevent dust suspension. We thereby reduce the dust directly from suspension and wet only the dust. As a result the amount of water required averages 1.5 gallons of solution per ton of coal produced at the face. It should be noted that this method was designed for reducing dust in mines where excessive moisture in the coal was prohibited by subsequent tipple preparation. It would apply equally well to dry mines where an ample water supply is not available for general spraying.

Laying Dust Eliminates Hazards

Why do we allay coal dust at the face? We have two explosion hazards in coal mines—gas and dust. The latter is particularly prevalent in mechanically operated mines. A 5 percent methane and air mixture is explosive; good ventilation removes this hazard.

Five one-hundredths of an ounce of fine coal dust suspended in 1 cu. ft. of air is explosive. Coal dust with 65 percent uncombustible, and coal dust mixed with rock dust to a state 58 percent uncombustible, have been exploded by the Bureau of Mines.

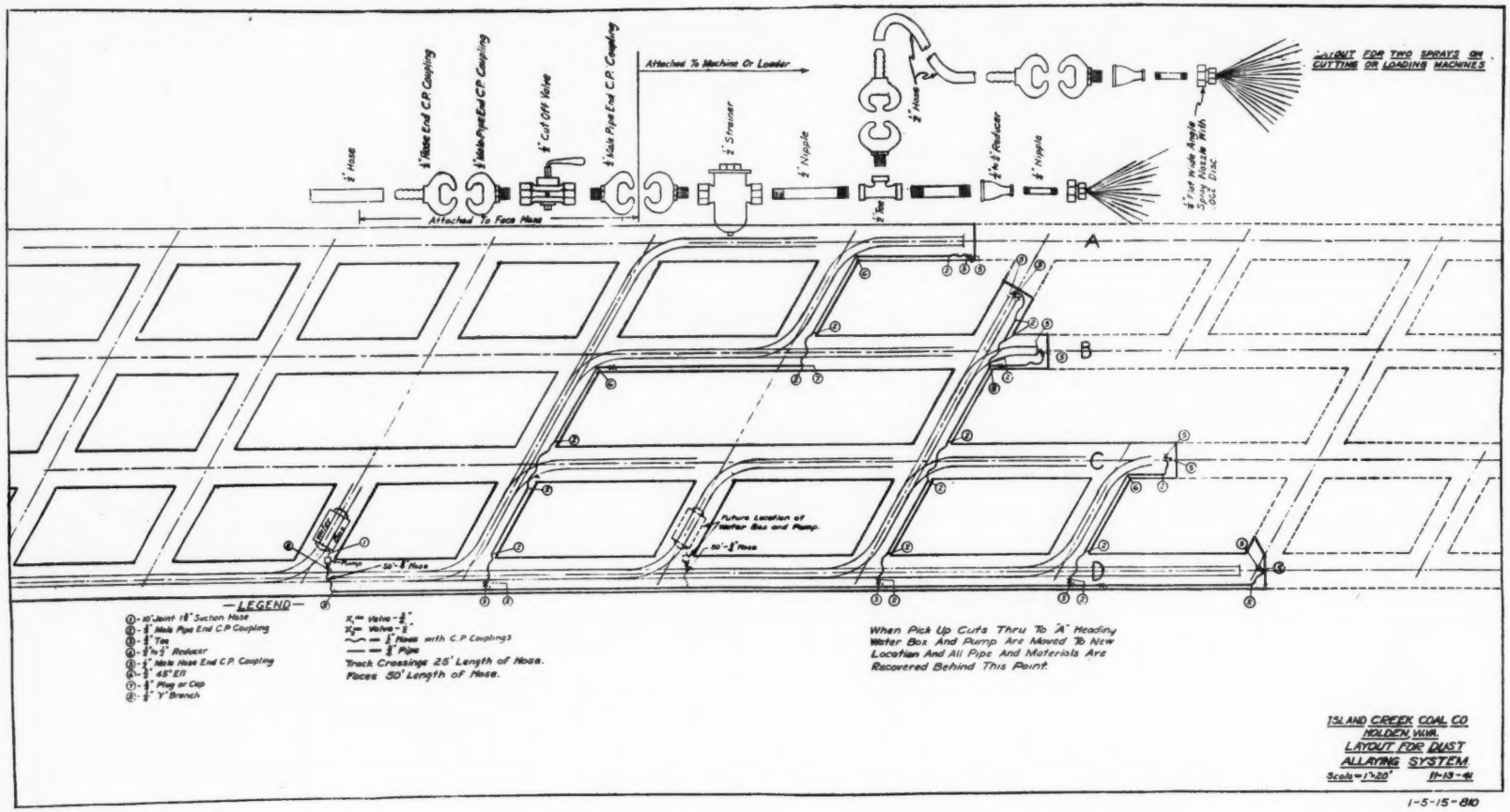
We have good ventilation and we now add spraying at the face, believing that both are effective and essential to the safety of our employes and the protection of our property.

Effective rock dusting close to the face quickly becomes ineffective due to contamination with coal dust spread over its surface. Allaying the coal dust eliminates an explosion hazard, keeps our rock dust and our investment in it effective. In addition, we provide sanitary working conditions for our men and permit maintaining high production rates with greater safety because of greater comfort and better visibility.

Wetting Agents Increase Effectiveness of Water Sprays

Relative to the use of wetting agents: We know too little of the fineness and character of our dust to give any technical data on the effectiveness of wetting agents. In a practical test and by observation we believe it greatly increases the effectiveness of our sprays. Relying again on the Bureau of Mines and Mr. Forbes, we

* Revision of paper presented at Coal Mining Institute of America meeting at Pittsburgh, December 12, 1941.


1" Hose
1" Hose End C.P. Coupling
1" Male Pipe End C.P. Coupling
1" Cut Off Valve
1" Male Pipe End C.P. Coupling
Attached To Machine Or Loader
1" Strainer
1" Nipple
1" Tee
1" Hose
1"x1/2" Reducer
1/2" Nipple
1/2" Flat Wide Angle Spray Nozzle With Oct Disc
LAYOUT FOR TWO SPRAYS ON CUTTING OR LOADING MACHINES
Attached To Face Hose
A
B
C
D
Future Location of Water Box and Pump
50'-1" Hose
Pump
50'-1" Hose
LEGEND
1- 10' Joint 18" Suction Hose
2- 1" Male Pipe End C.P. Coupling
3- 1" Tee
4- 1"x1/2" Reducer
5- 1" Male Hose End C.P. Coupling
6- 1" 45° Ell
7- 1" Plug or Cap
8- 1" Y Branch
X1= Valve - 1"
X2= Valve - 1/2"
1" Hose with C.P. Couplings
1" Pipe
Track Crossings 25' Length of Hose.
Faces 50' Length of Hose.
When Pick Up Cuts Thru To "A" Heading Water Box And Pump Are Moved To New Location And All Pipe And Materials Are Recovered Behind This Point.
ISLAND CREEK COAL CO
HOLDEN, W.VA.
LAYOUT FOR DUST ALLAYING SYSTEM
Scale = 1"=20'
11-13-41
1-5-15-810

Layout of the dust allaying system at an Island Creek mine

have information that "our tests have indicated thus far that the use of a proper wetting agent properly applied should reduce the dust to at least half that found in the air when water is used to allay the dust and approximately half or even less the amount of liquid generally is applied to accomplish this result."

The statement generally is in accordance with our observations, and the use of a wetting agent is definitely indicated in our case.

Relative to the equipment: It is necessary that the complete spray equipment be designed so that it can be quickly advanced with the rapid progression of the face. Even more important is the necessity that all sprays operate continuously and effectively. Our design has proved that spray stoppage can be practically eliminated with little cost of attendance. Generally all the equipment has proven very suitable for the work and will have a satisfactory maintenance cost.

The Island Creek Coal Company loads 100 percent of its production by mobile loaders, using track and shuttle car equipment. Production at present is about 30,000 tons per day. Thirty-five spray units are in use at this time, protecting practically all the production.

The Equipment Has Proved to be Satisfactory

The following description of the equipment and installation was prepared by R. G. Lazzell, our production engineer:

For experimental purposes a water box with a capacity of 1,000 gallons was built and mounted on the trucks of a mine car. A recess was provided in one end to accommodate a small turbine-type pump, bolted in, making the unit complete. A 20-mesh bronze strainer was provided in one of the openings in the top of the box so as to assure as clean water as possible when being filled. The pump was a 1¼ in. x 1¼-in. two-stage bronze, fitted turbine pump, driven by a 1½-hp., 230-volt, d.-c., compound-wound motor and capable of furnishing eight g.p.m. at 125 lbs. per sq. in. pressure. The pump was installed with a strainer and check valve on the suction end and a pressure gauge and a spring relief by-pass valve on the discharge side in order to protect the pump and maintain pressure. Three-quarter-inch galvanized pipe was used to conduct the water to the faces. The water box and pump were placed on an unused spur track in the first break-thru below the active workings. The pipe line was laid alongside the tracks into each of the working places. In order to avoid cutting and fitting pipe at the track crossings, 25-ft. joints of ½-in. hose with C. P. Universal couplings were used. The hose was placed under the track and between the ties and protected as much as possible by trenching and filling. Fifty-foot joints of ½-in. hose with the same couplings were used in each face. A section of ¾-in. hose was used from the pump discharge to the ¾-in. line in order to have a quick method of attaching the pump on the line each day after the water box had been taken out and refilled. Stop and waste valves were provided at the mouth of each working place and at a few points along the line so as to be able to isolate any part of the line for repairs on extensions without interrupting the spraying on the remainder of the system.

On the end of each 50-ft. joint of hose at the working faces a ½-in. stop and waste valve was connected with C. P. couplings to speed up connecting to the cutting and loading machines.

Sprays Mounted on Cutting Machines and Loading Machines

Two sprays were mounted on both the cutting machine and loading machine. On the cutting machine, a 324 AA Goodman, the sprays were mounted on each side at the trunions so that the sprays would cover each side of the back end of the cutter bar between the sprocket and the entrance to the kerf. These two spray heads were connected by ¼-in. nipples to a common ½-in. line containing a ½-in. brass strainer with openings in the strainer not greater than .05 in. The connection from the machine to the face hose was, of course, provided with a C. P. coupling on the right-hand side of the machine.

The loading machine, an 11 BU Joy, was fitted with two sprays in the same manner. The sprays were mounted beside the headlights so as to spray through a hole cut out of the side guard of the loading head of the machine. The spray heads were set so as not to protrude to where they would be knocked off by the coal.

All hoses in use are high-grade 2-ply, 250-lb. pressure rubber hoses and after eight months of service show very little signs of deterioration and abrasion. Occasionally a hose has been cut by cars or by the falling of a large lump of coal where the hose was resting on the hard bottom.

After experimenting with several different types of spray nozzles, it was found that the most satisfactory type was the wide angle flat spray type. This gave greater coverage and tended to allay more dust.

Flat Wide-Angle Sprays Most Suitable

Although different type sprays are used on the cutting machines at other operations, our experience has shown for our purposes that the flat, wide angle sprays on each side of the cutter bar can be adjusted so as almost to completely hood over the cutter bar with a fine mist and trap the greater part of the dust.

The size orifice used in the sprays is .062 in. and will spray at the rate of .72 g.p.m. at 75 lbs. per sq. in. pressure. The pressure carried at the pump varies from 80 to 100 lbs. per sq. in., according to the distance between the faces and pump.

With four sprays, two on the cutting machine and two on the loading machine, the consumption of spray solution has been about 700 gallons per shift.

At the end of each shift the water box is taken out and refilled at a central filling point and the wetting agent added; it is then returned to the section, ready for the next shift.

The amount of labor required to operate the sprays is about one man shift per day. About one-half of one man's time is required to extend the pipe lines in the faces, recover the discontinued lines and generally look after the installation. On the average, about two man-hours per water box is required to fill the boxes and return them to the sections.

No loss of time or production is caused by the use of the sprays. By the use of the quick connections on the hoses, the connection of the water to the machines is a matter of a very few seconds.

Water Box and Pump Have Been Improved

In equipping other sections for spraying, the only change from the equipment used on the experimental section has been in water box and pump. It was found that a 1¼-in. x 1¼-in. single-stage turbine-type pump delivering 6.2 g.p.m. at 125 lbs. per sq. in. was satisfactory and of

(*Continued on page* 42)

GEOLOGICAL FACTORS IN RECENT ORE DISCOVERIES

● **Where is the ore of the future to be found? No question is of greater importance to the continued well-being of the mining industry, particularly now that known ore deposits of almost all metals are being depleted at an unprecedented rate to supply the war effort. It has been apparent for several years that known and developed deposits were being used up at a rate much faster than new ore deposits, or extensions of already-discovered deposits, were found.**

It is desirable and inevitable that, in this search, a greater and greater dependence must be placed on close geologic study. The following series of papers and discussions, in part a revision or condensation of those presented at the recent Metal Mining Convention of the American Mining Congress in San Francisco, is published here as a valuable contribution to the solution of this question. The authors, in pointing out what has been done in recent years, indicate the course that ore-exploration must take in the years to come.

Discovery in The INTERMOUNTAIN AREA

By W. R. LANDWEHR
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IN order to determine the factors responsible for the most recent outstanding ore discoveries in the Intermountain area and to predict the methods that will prove the most successful in ore discovery in the future one must look back over a period covering at least two decades. It is also necessary, in order to cover the problem comprehensively, that ore discoveries made in operating properties be included, as well as the more publicized discoveries of new mines.

Fourteen Mine Discoveries Are Cited

As a basis for discussion there has been selected from the mines with which I am familiar in the Utah, Nevada, and southern Idaho region a group of 14 in which the major ore discoveries of the past twenty years or so have been made. In making the selection it is realized that the limit which defines the group as the most outstanding must, of necessity, be set arbitrarily and could be changed to include a greater or lesser number of mines, without however appreciably modifying the discussion, or the conclusions. Also in making the selection discoveries which have resulted from the stimulus of national defense are excluded, although it is realized that this factor has been, and probably will be, responsible for the discovery and exploitation of important mineral deposits.

The 14 mines selected are: The Bingham Prospect and Bingham mines (now the Lark mines of the U. S. S. R. & M. Co.) in the Bingham district; the Silver King Coalition, Park City Consolidated, New Park and Park City Utah in the Park City district; the Tintic Standard mine, North Lilly-Eureka Lilly area, and Eureka Standard mines of the East Tintic district; the Combined Metals mine at Pioche, the Triumph mine near Hailey; the Consolidated Copper mine at Ely; and the Mountain City and Getchell mines in northern Nevada. Many of these have been large producers for a good many years but come within the scope of this discussion in that they have been the site of important new ore discoveries within the past two decades. The following brief statements relative to some of the mines will illustrate the methods of exploration employed and will serve to emphasize the factors responsible for the ore discoveries.

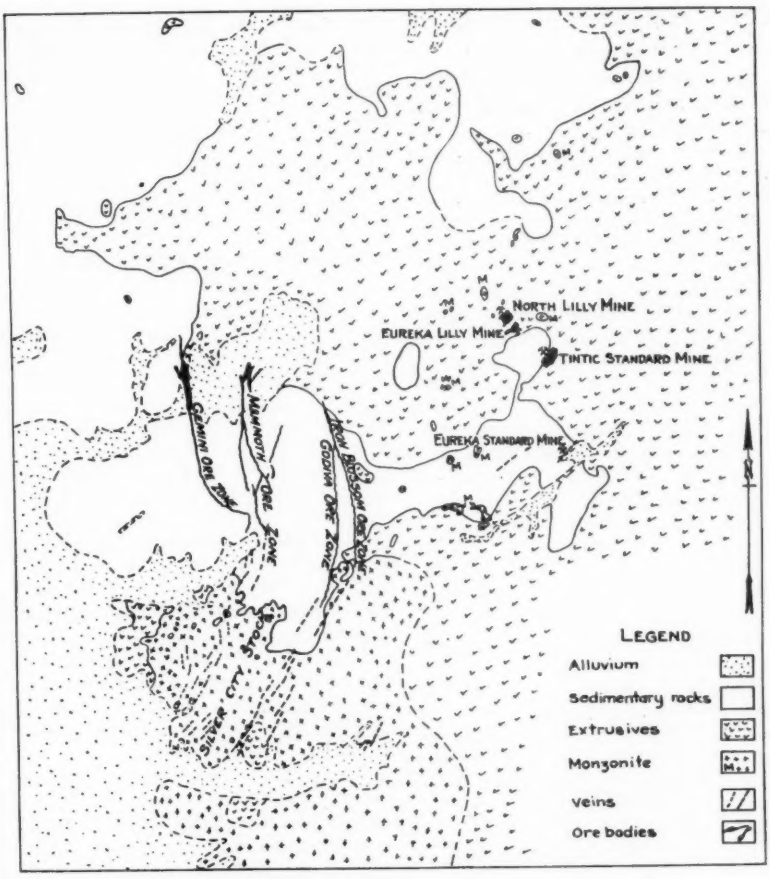
Knowledge of Favorable Geologic Conditions Results in Successful Exploration

The discovery of the Bingham Prospect, which is located in the eastern part of the Bingham district, was based upon the concept that the most intense mineralization in the district occurs in a relatively narrow elongated zone which trends approximately in an east-west direction, and that any ground along the extension of that zone in which the proper combination of limestone and fissures of the mineralizing system could be found, was worth prospecting. Accordingly an area in the eastern part of the district which seemed to meet all requirements was selected. Most of the surface was occupied by quartzite and andesite. The exposed fissures were few, small, and non-productive, consisting principally of small seams of iron oxide with lesser amounts of

lead minerals. Earlier exploration work had been shallow and the results discouraging. Deeper exploration along the proper fissures and in the proper limestones resulted in one of the major ore discoveries of the district.

The Silver King Coalition has for years been one of the outstanding mines of the west. In 1919, however, it passed through a discouraging period when ore reserves were low and no new ore bodies were being found. A complete geological study of the mine led to a better understanding of the factors of ore control, and prospecting based upon this knowledge soon improved the ore situation. The subsequent ore discoveries which were and are the result of a strict geological control of prospecting, rank among the outstanding in the Intermountain region.

The discovery of the Park City Consolidated mine in the Park City district was the result of the application of the same methods as were used in the discovery of the Bingham Prospect—and incidentally by the same geologist, J. J. Beeson. The basic structure in the Park City district is an open anticline whose axis strikes northerly. Over a large area in the central part of the district the productive Park City formation has been eroded from the crest of the anticline, exposing the underlying Weber quartzite. On the west flank, in the Park City formation, are the large replacement bodies of lead-silver ore of the Silver King Coalition mine. On the east flank, approximately opposite the Silver King, is the Park City Consolidated. The ground which now constitutes the Park City Consolidated mine was selected because, (1) it lay along the northeastward extension of the main general zone of intense mineralization; (2) was directly along the line of strike of the Silver King zone of fissures; and (3) the Park City formation was known to be present at a minable depth. The presence of mineralizing fissures of the proper system could be determined only by the displacement of the sedimentary rocks, for they contained no mineralization other than an occasional isolated crystal of vein quartz. Exploration prior to the date of acquisition consisted only of a short tunnel and a few shallow surface pits, none of which encountered encouraging mineralization. The top of the ore was encountered about 400 ft. below the surface and since that time—1929—the mine has produced steadily.



Geologic sketch of the Tintic district

Conditions at Depth Are Important Factors

The most recently developed mines in the Park City district are the New Park and Park City Utah which, like the Park City Consolidated, lie in the extension of the main belt of mineralization. Depth was the important factor in both cases, the veins being more intensely mineralized on the present lower levels than at the surface.

The development of the main Tintic Standard ore body was the forerunner of a number of important discoveries in the East Tintic district. It was determined that the formation of that ore body resulted from a combination of mineralizing fissures of the northeast system and replaceable limestone horizons in the Ophir shale series. This determined fact has been the basis for all exploration in the Tintic Standard mine since the discovery of the original ore body. Exploration therefore necessitates a detailed knowledge of the structure of the area, both in regards to the position of the fissures, and the position of the various limestone beds. The well-planned exploration practices by the company has found additional ore bodies which are among the outstanding discoveries in the district.

The knowledge relative to the geologic factors controlling the formation of the Tintic Standard ore body was applied in the discovery of the North Lilly-Eureka Lilly, and Eureka Standard ore bodies. The surface of the East Tintic district in the vicinity of the mines is largely covered with rhyolite flows which post-date most of the major faulting, so that the surface reveals little relative to the structure in the underlying sedimentary rocks. Slight post-rhyolite movement along existing faults in the sedimentary rocks did little more than to fracture the rhyolite, especially along the lines of the mineralizing fissures. The rhyolite is pre-mineral, but as the horizon of major deposition lay in the sedimentary rocks at considerable depths below the present surface, the exposed rhyolite was subjected only to the upward reaching wisps of the mineralizing agents.

Alteration at Surface Gives Indication of Underlying Conditions

A detailed study of the surface revealed an area in which the rhyolite was bleached and partly silicified, and carried traces of silver. The alignment of the alteration suggested fissures of the mineralizing system. By comparison with the Tintic Standard area the alteration and silification in the rhyolite was interpreted as the reflection of more intense mineralization in the underlying sedimentary rocks. Churn drilling proved the presence of the Ophir formation beneath the rhyolite. There was therefore indicated the proper combination of factors for the formation of an ore body; namely, fissures of the mineralizing system and replaceable limestones. Subsequent exploration discovered the ore bodies of the North Lilly and Eureka Lilly mines.

The discovery of the Eureka Standard mine duplicates that of the North Lilly and Eureka Lilly. The same alteration of the rhyolite indicated the presence of more intense mineralization in the underlying sedimentary rocks. The Ophir formation was known to be present beneath the rhyolite. Exploration along the Eureka Standard fault resulted in the development of the Eureka Standard mine.

Combined Metals Mine an Outstanding Example

The development of the Combined Metals mine at Pioche must be considered one of the outstanding examples of ore discovery in the Intermountain west, although in this case, after the initial discovery, the incentive for exploration was dependent upon the development of selective flotation. The original discovery was made by the early operators, but as the complex lead-zinc ore was of no immediate value no further development was done. Later E. H. Snyder, after a study of the geology of the district, came to the conclusion that there was a strong probability that large ore bodies existed in the Pioche shale along the extension of the main mineralized zone. The initial prospecting revealed the manner of ore occurrence and thereafter development, based upon a detailed study of the geology which involved the correlation of mineralizing fissures with structural conditions, resulted in the discovery of the large ore bodies upon which the present operation is based.

The incentive for the exploration that resulted in the most recent ore discoveries in the Triumph and adjoining properties, as was the case in Pioche, was primarily the result of improvement in the technic of selective flotation which made possible the separation of the complex lead-zinc ores. The selection of the properties for exploration by the present operating company was based upon the realization that the chances for success are greater in the more intensely mineralized areas than elsewhere. It was this realization that led to the consolidation of the properties along the Triumph zone and the exploration campaign which has made the mine one of the most important producers in southern Idaho.

The Consolidated Copper Mines Corporation at Kimberly, Nevada, has greatly increased its ore reserves in the past few years. Kenyon Richard, assistant chief geologist, describes their method of exploration as follows:

"Basically, successful exploration has been accomplished by a realization of the part which structure has played in the control and guidance of successive waves of mineralizing solutions of considerable magnitude. The processes of intrusion, metamorphism, and mineralization have so obscured the important structural relations that, until the accumulation of detailed geologic data was begun, much of the exploration by churn drilling was of an expensive "wild cat" nature. Compilations of the detailed geology over a period of years have revealed major problems of structure and mineral distribution. Our churn drill exploration has been guided by these patterns.

"An interesting fact is that all the areas in which the ore bodies have been extended can now be boiled down to comparatively simple geologic pictures; but cognizance of their simpleness was dependent upon the accumulation of a mass of detailed geologic data, 90 percent of which may never be of economic significance."

It is evident from the foregoing that the successful exploration conducted by this company is based upon a thorough and detailed knowledge of the geology of the Ely district as a whole, the use of which has removed much of the expensive uncertainty inherent in the "wild cat" methods previously employed.

Old-Time Prospectors Still Play a Part

Of the group of mines selected the Mountain City Copper and the Getchell mines stand by themselves, in that they are located in districts which, before the discoveries, had had relatively little productions, and both were discovered by what might be termed the "old school" methods of prospecting. As is almost universally known faith in a barren gossan, based upon the experience of years of prospecting, was responsible for the discovery of the Mountain City ore body. The Getchell mine, now producing over a thousand tons a day, lay undeveloped until chance prompted a prospector to assay the outcrop.

Park-Galena unit of New Park Mining Company

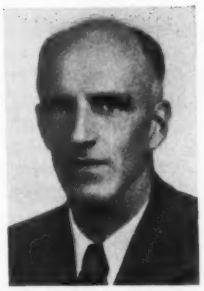
Twelve of the Developments in Fields Previously Known

The first noticeable fact relative to the properties selected is that 12 of the 14 are in the proved major districts. The remaining two are isolated mines in areas of small production. The preponderance in number of the discoveries in the areas of major mineralization is perhaps in part due to the fact that profits derived from the districts supply the incentive and capital for more intense exploration. Also, because a mineralized district is a geological unit in which all parts are interrelated, a better understanding of the geology has been a factor conducive to more successful exploration. Experience, however, dictates the conclusion that the more intense and widespread mineralization of the larger districts has, in itself, provided the most profitable field for past exploration.

The second fact is that the majority of the discoveries were due to sound geological deductions based upon a comprehensive knowledge of the district in question. To obtain the necessary knowledge upon which to base a sound exploration campaign requires that the proper technical skill be applied for a sufficient period of time. Hasty or haphazard methods are worse than useless. Briefly the procedure leading to the final conclusion consists of two parts, first the procurement of data, and second its interpretation. The first involves the accumulation of much that will, in the end, prove unusable, but at the time of collecting it is impossible to know all that is, or is not, pertinent. Interpretation of the accumulated data leads to the final conclusions, and the degree of success of any exploration based thereon obviously depends upon the correctness of that interpretation.

The general conclusion to be drawn is that in recent years the more profitable exploration in the Intermountain area has been that which was confined to the larger districts, and was based upon a detailed and comprehensive knowledge of the geology involved in any particular case. Although the opportunities are rapidly diminishing it follows as a corollary that the more profitable exploration in the future will follow the same path.

Status of Ore Discovery in CALIFORNIA and OREGON



By CARLTON D. HULIN
Department of Geology
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IMPORTANT discoveries of new ore in California and in Oregon have not been numerous within recent years. Of the new discoveries which have been made, chance it must be acknowledged, has played an important part. While on occasion chance discoveries may have been guided by geologic principles, in general geology appears to have played only a minor role.

It is not my purpose merely to catalog the recent discoveries and developments of new ore; rather the effort will be made to classify some of the more recent ore discoveries as to cause, in an attempt to decipher how geology might best be made to serve in the future enlargement of our known ore reserves.

Geologic Studies Not a Preponderant Factor

Comparatively few of the mining companies operating in California or in Oregon have seen fit to make use of formal geological studies in connection with mine exploration and development, although in many cases incidental geologic work has been attempted. And the application of formal geology in the search for new mines has been a rare event.

Among the mines where the value of formal geological studies has been recognized may be mentioned the Idaho Maryland at Grass Valley, the Central Eureka near Jackson, the Pine Tree and Josephine in Mariposa County, the Iron Mountain in Shasta County, the Golden Queen at Mojave, and several of the quicksilver mines located in the California Coast Ranges. While these by no means complete the list, the small number of mines cited may serve to indicate the lack of attention paid to the geology of their deposits by many mine operators.

As regards the value of such detailed geologic study to the mine operator, I would venture the opinion that the present status of the Idaho Maryland as the foremost gold producer in California has been very largely the result of a clear understanding of the geologic structure of the complex vein system which is represented in the Idaho Maryland and New Brunswick mines. And I would venture a similar opinion for the Central Eureka which now ranks third in production among the California gold mines.

Price and Demand for Metals Are Large Factors

While recognizing clearly that many of the recent ore discoveries represent the result of chance, perhaps assisted on occasion by an application of geologic principles, several important factors which have had a vital effect on the rate of these chance discoveries may be indicated. One factor is the increased price and demand which has existed for certain metals during recent years.

The increase in the dollar value of gold which went into effect in 1934, provided the immediate incentive which led to the reopening of many old mines, and to the acceleration of exploration work in most operating gold properties. This increase in exploratory effort resulted, and is still resulting, in the opening up of numerous bodies of gold ore.

In Oregon, only a single important producer appears to have resulted from

the increase in the value of gold, namely, the Cornucopia mine, in Baker County in eastern Oregon.

In California, the increase in the price of gold led to a rehabilitation and placing in production of numerous old properties, and an extension of the life of operating properties. Only a single case, which is of more than passing interest, will be mentioned. The Alhambra Shumway mine, located in the Mother Lode belt in El Dorado County, was first worked in 1883, and has been intermittently worked since that time with a small production of high grade ore. The present operators acquired the property in 1937, and carried on a limited amount of development work which culminated in the early spring of 1939 in the discovery of a shoot of extremely rich ore. By the end of 1939 this shoot had produced 4,043 tons of ore with a gross value of approximately $615,000 in gold.

Quicksilver Production Stimulated by Higher Market Value

The effect of increased demand and higher market value on ore discovery is equally well exemplified in the case of quicksilver. The increased demand for quicksilver, resulting first from the partial cutting off of foreign supply by the revolution in Spain, and followed by the sharp increase in market price at the outbreak of the present world conflict in September, 1939, resulted in intensification of exploration and in the reopening of many old properties. In Oregon, the Bonanza mine in Douglas County, first worked between 1860 and 1870, has now become the foremost quicksilver producer in the United States. Important production is coming from other old mines, and in central and southeastern Oregon several new discoveries have added to the list of productive properties.

In California, most of the old mines of the state are in active operation, with the rate of ore discovery sufficiently high as to permit in general of continuous output.

The effect of increased demand is also shown by the stimulation of tungsten mining. While Atolia maintains its lead as the foremost tungsten producing area in California, important new developments have occurred in the vicinity of Bishop on the east side of the Sierra Nevada. Deposits of scheelite, of contact metamorphic nature, were first discovered in this region in 1913 as the result of gold placer operations. However, except for a limited period during the first world war, important developments of these scheelite deposits awaited the incentive offered by the increased demand for tungsten which has existed within the last few years.

Adaptation of Mining Methods Is Another Factor

Another important causative factor which has added to the list of productive deposits in California is found in technological advance. This has consisted primarily of the adaptation of low cost methods of mining to bodies of ore which had previously been regarded as uneconomic. A pioneer in this field in California is the Iron Mountain mine in Shasta County, where power shovel open pit methods of mining were initiated about 1929 on a large body of leached gossan carrying low grade gold and silver values. The operations at Iron Mountain have been completely successful and are still in progress. Early in 1940 similar shovel mining operations were started at the nearby Willow Creek mines, likewise a gossan deposit. On the Mother Lode, power shovel mining accounts for an important portion of the ore treated at the Carson Hill mines, fifth producing gold mine in California.

In southern California, shovel operations were carried on for several years on low grade ores of the Yellow Aster Mine at Randsburg. And not far distant, on the outskirts of the old Calico district, development at the Burcham Mine has proven in excess of 2,000,000 tons of low grade gold and silver ore. Not yet equipped for production, the incentive for the Burcham development is to be found in the adaptability of the ore bodies to mining by low cost power shovel methods. The incentive for the development of low grade ore bodies offered by these methods has not been limited to precious metal mines in California, but has likewise been the incentive at a number of quicksilver deposits. Open cut shovel methods have been in use for a number of years at Sulphur Bank, and more recently similar methods have been put to use at the Mt. Diablo Mine, and at the famous old New Almaden Mine.

One Mineral Discovery Stimulates Search for Others

Still another cause leading to ore discovery is to be found in the increased exploration activity which normally occurs in any area following an important mineral discovery.

Perhaps the most important new discovery made in California in recent years was the Golden Queen, found purely by chance during the fall of 1933 in the heart of the old Mojave mining district. Due to the intense interest aroused by this discovery, prospecting and exploratory efforts in the area were greatly intensified, with the direct result that other important deposits, including the Cactus Queen, the Middle Butte Mine and the Starlight, were developed.

All These Factors Combine in Obtaining Results

The discussion to this point is strongly suggestive that most recent ore discoveries in California and in Oregon have resulted largely from chance, and that the rate of ore discovery is a function of the intensity of prospecting and exploration effort. Any factor which offers an incentive for an increase in the exploratory effort would appear to have a resultant effect in increasing the rate of ore discovery. Such factors may be an increase in value or in demand for a metal; or an increased local interest following an important discovery; or an increased interest resulting from the possible application of an improved technology.

While it is apparent that geology has not in general assumed an important role in connection with ore discovery in California and Oregon during recent years, it must not be assumed that geology is incapable of assuming such a role.

Geological knowledge is available today, which, if properly applied, is quite capable of leading to ore discovery. I know of no science, however, which is as complex in its application as is that of mining geology, nor which demands greater ability on the part of the man who would make use of it. The ability to apply geology to mining implies more than the mere title.

Two types of ore discovery problems confront the mining geologist. The first of these involves the location of new ore bodies within the environment of developed mines. The second involves the location of entirely new deposits. Both types of problem are subject to solution in the light of present-day geological knowledge.

The location of new ore within the confines of developed mines is perhaps the simpler problem of the two, although still one which calls for the highest qualifications on the part of the worker. The problem, while fundamentally one of geologic structure,

may call for knowledge in any phase of geology.

Only one example will be considered, and that one involving a recent ore discovery in California. At the Palisades Mine, located in Napa County about 75 miles north of San Francisco, an ore shoot was discovered in the fall of 1938 which subsequently produced in excess of $500,000 in gold and silver. Prior to its actual discovery, the probable existence and position of this ore shoot were indicated on the basis of purely geological evidence, and this at a time when no portion of the ore shoot had been anywhere exposed. It subsequently developed that values were encountered within 15 ft. of the position where possible ore had been predicted, and while such accuracy was unquestionably fortuitous, it nevertheless indicates what may on occasion be accomplished through the application of pure geology.

Discovery of New Deposits Is Difficult Geologic Problem

Geological discovery of entirely new deposits represents a more difficult problem and one calling for even greater ability on the part of the mining geologist.

In the early years of the petroleum industry the oil companies were forced to recognize the necessity of widespread and systematic geological investigations in their efforts to isolate potentially productive areas and bring those areas into production.

Such procedure is essentially unknown in the search for new mines. Ordinarily in the attempt to establish a new mine, our mining companies merely examine, following normal procedure, such properties as are submitted to them. And many such properties have been examined and reexamined by various mining companies. In those rare cases where more detailed geological studies are attempted, the work is usually restricted to the immediate district in which the mining company is operating producing mines. In certain such cases of which I have record, such detailed studies have been well repaid. It seldom happens, however, that in the search for new mines detailed geologic studies are carried on in areas in which the mining company is not at the moment operating. And yet, in my opinion, such procedure should inevitably lead to the discovery of important new deposits.

Although actual examples cannot be given in which detailed geologic studies carried on outside of operative areas have led to ore discovery, two cases in California may be cited where, had such procedure been followed, important ore discovery would have resulted. The camp of Randsburg has been actively mined from the time of its discovery in 1895. And yet, one of the most important ore deposits of the area, the California Rand Silver Mine, remained unknown until found purely by chance in 1919. This mine has subsequently produced nearly $20,000,000 in silver. A detailed geologic study of the camp made prior to 1919 would inevitably have led to the discovery of this deposit.

Again, at Mojave, not far distant from Randsburg, mining has been continuously active, starting with the discovery of the camp in 1894. And here again, lying in the heart of the district, the most important ore deposit present remained unknown for 39 years until chance led to its discovery. The Golden Queen deposit would certainly have been found had any detailed geologic study of the Mojave area been made prior to 1933.

I do not regard these cases as unique. Most mineralized areas are marked by one or more "centers of mineralization" where the most valuable deposits of the area occur. In some districts these centers of mineralization have been found and developed, and important mines and important mining camps are the result. But in many mineralized areas the "plums" represented by the centers of mineralization have not been found, and in consequence such areas remain unimportant and perhaps relatively unknown. While it must not be construed that every mineralized area necessarily contains such "plums" awaiting discovery it must nevertheless be recognized that such centers of mineralization, characterized by important deposits, do exist undiscovered in many mining camps, and the discovery of these is possible by detailed geologic methods.

A detailed study of a succession of mineralized areas should lead to the discovery of important new deposits. Such a discovery might not be made in the first area studied, nor even in the second or in the third, but sooner or later a deposit should be discovered which would more than repay the cost of all efforts up to that time.

I would recognize in this procedure one which our mining companies must ultimately be forced to adopt if the rate of ore discovery is to be maintained in the future.

The Golden Queen mine, near Mojave, Calif.

Ore Discovery in COLORADO, WYOMING and the BLACK HILLS

By JAMES BOYD

Associate Professor of Geology, Colorado School of Mines; on leave with The Commodities Division, Office of the Undersecretary of War

IN the region covered by the scope of this paper (Colorado, Utah and the Black Hills) there have been no important discoveries of new deposits during the last 10 years, but there have been found extensions of deposits previously known. For this reason it is necessary to confine remarks to the factors contributing to the discovery of these extensions.

These Regions Have Had Few Virgin Discoveries

The Black Hills have produced no virgin discoveries during this period. The Homestake Mining Company has, however, applied geology intensively to all its exploration and development work and, as is generally known, has continued to find sufficient ore not only to maintain ore reserves, but also to effect a fairly substantial increase. Guy N. Bjorge, the general manager, does not feel at liberty to discuss the details at this time, but enough papers have appeared on the Homestake mine from time to time to indicate the general nature of the exploration. This area of highly complex geology has undoubtedly taxed the resources of able geologists working in extreme detail, and aided by properly planned drilling and underground development. The principal factor responsible for the discovery of new ore is the size and richness of the deposits, which have encouraged the management to employ to the full the services of geologists and who in turn have become a part of the operating organization. Development here as in many large mines is not the result of hit-and-miss methods but of carefully planned scientific investigation.

In Wyoming the only new discovery during this period has been the extension of the Iron Deposits at Sunrise. The author is not personally familiar with the facts of discovery of these extensions, but the Colorado Fuel and Iron Company has made careful geological investigations and has experimented with various geophysical methods, not only in the search for new bodies, but in an attempt to control their mining operations by obtaining a better knowledge of the progress of the caving above the stopes.

Geological Mapping Has Been an Important Aid

Colorado has seen few intensive searches for virgin ore in the past 10 years. Gold mining has increased for obvious reasons, but within the knowledge of the author and his correspondents there have been few important new discoveries. One of the exceptions is the remarkable work done by the Slide Mines in Boulder County; the mine, although relatively small, has consistently maintained a full geological staff and, through their efforts, has managed to grow continually. The results are best expressed in the words of Joseph H. Rodgers who has been in charge of geological exploration for the company; he speaks, however, for Boulder County as a whole: "The important ore discoveries in recent years in this district have been due to geological mapping of old mines and realizing the effect of structural control on ore deposits. This has led to lateral and vertical extensions of ore bodies which were thought to have been worked out. It was found that the interruption of the ore, both laterally and vertically, was due to structure. This being known, development directed to nearby areas where similar geologic conditions existed, revealed ore bodies not previously known, and which did not outcrop at the surface.

"Geological mapping, which includes the identification of rock alteration due to mineralizing solutions; from alteration which is due to regional metamorphism; mineralogical mapping; zoning; and geophysical mapping, all are used to advantage, especially when in conjunction with diamond drilling.

"It has been found that ore occurs in minable quantities only at sharp bends in certain veins. Where the outcrop is covered geophysical methods readily outline the sharp turns in the veins and development can be confined to the favorable portions. Most prospectors and operators are easily convinced of this and will cooperate willingly.

"Several good discoveries have been made by miners driving on veins until ore was encountered. However the percentage of success by this method is very low."

Colorado also produces many minerals essential to national defense, notably molybdenum, vanadium zinc and lead. In some cases the reserves are large, but should the demands made by the present emergency continue at their present level they may be depleted rapidly; the situation might easily become serious because reserves even when known usually require several years to develop. To quote John W. Vanderwilt Climax Molybdenum Company: "I only hope that serious shortages may develop in peace time rather than in war time. Much of the ore reserves we now enjoy were developed during the first World War, and if they prove adequate today we will be lucky."

Ore Reserves Developed Despite Bad Market Conditions

Mining companies naturally are not prone to develop large reserves of minerals the value of which may decrease as time goes on. A refreshing exception is illustrated by development at the New Jersey Zinc Company's mine at Gilman. The method of development, although it was probably forced on the company by market conditions, might well be applied elsewhere deliberately. Conditions have existed which have allowed the company to develop large reserves of zinc at the same time

production has been made from copper-silver ore bodies. This has been possible because there are two separate and distinct types of ore bodies which are geologically related but which differ mineralogically. These are the zinc mantas or blanket deposits and the copper-silver pipes. In recent years the search for and discovery of zinc deposits has continued, but these have not been worked. As a result, today, when zinc has become an important and critical metal, the company has large reserves which they are producing for the defense industries.

The factors which have been responsible for the discovery of these deposits are the peculiar geological relationships, the market conditions and the far-sighted policy of the company in maintaining geological investigations of the zinc deposits, while they were developing and producing the copper-silver ore bodies.

The ore finding work at Climax is well known. This is not a new discovery because impetus was given to its development during the last World War, but the need for the scientific approach to ore discovery was brought to the company's attention by the work of the United States Geological Survey. Today geological investigation, as at Homestake and Gilman, is an intimate part of its development program. The staff geologists are not only charged with increasing the company's knowledge of ore reserves, but with so outlining them that development can be planned intelligently in advance.

Leadville Revival Due to Geological Study

Leadville has been in the doldrums for many years, but in recent months extensive low-grade deposits have been opened for production in the Resurrection area, at the head of Evans Gulch. These bodies were discovered as the direct result of carefully planned development based on studies of geological conditions described in the published works of Loughlin and others.

This may appear to be wandering away from the subject but the author feels very strongly that ore discovery is not something separate but must be an intimate and continuing part of every mining operation. If a company finds ore reserves are becoming exhausted, it must know well in advance so that attention can be directed elsewhere. In trying to find the factors which have led to ore discoveries, which have been all too few in this area, specifically it behooves us to analyze the factors which should lead to future virgin fields. The three largest companies mentioned above have applied the scientific approach to assure continued operation. They have been fortunate in having relatively large reserves at their immediate location, but if their reserves began to dwindle they would have two choices; one, to discharge their geologic staff, cease exploration activities and begin to liquidate; the other, to begin with their geological staffs a campaign by the same scientific methods more broadly applied in the search for virgin deposits. This subject has been covered by the author in the MINING CONGRESS JOURNAL of May, 1941, and need not be repeated here.

San Juan Discoveries by Age-Tested Methods

The San Juan Region of Colorado presents a picture somewhat different from those previously mentioned but is illustrative of the point in question. The Red Arrow, a gold mine in the La Plata Mountains, was discovered by the age-old method of panning the coarse gold up a small draw until the values disappeared. In this case a search of the slope above revealed the cropping of gold in a sandstone ledge. Although this is a fairly recent event it does not materially contribute to this subject because the method is well known and time tested. It has a lessening field of application because most of our draws have now been panned.

The discovery of the Flat Vein in the Smuggler-Union took place as the result of normal development work; to quote Charles W. Bell of the Camp Bird Mine: "We were drifting north in the long ore-shoot on the Smuggler vein at No. 11 level, when a vein crossing the Smuggler at an acute angle was encountered. With an exposure of only the height of the drift and a length of 8 ft. along the strike, we projected the vein to the surface, a vertical distance of 2,000 feet, and located claims covering the apex. My guess is that the gross production now exceeds $18,000,000 and it is still producing." It can be said, though, that this most commonly used method of ore discovery, even in a region as intensely mineralized as Colorado, has produced only one such ore-body in 27 years; notwithstanding that an enormous amount of drifting of the same type has been carried on all over the state. As a further example, new ore shoots have been discovered in the veins of the Shenandoah-Dives by persistent development along known fissures.

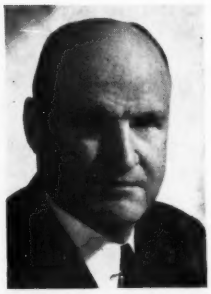
Two of my correspondents on this subject, Wilbur S. Burbank, U. S. Geological Survey and Charles N. Bell, agree that the recent discoveries of many small bodies of ore have resulted from persistent work along the extensions of known veins of ore-bearing fissures, but with the exceptions noted, none have been large.

For favorable results from development of any kind, however, it is most necessary to have an intimate knowledge of the habit of the fissuring and the occurrence of ore shoots in a given district. Important contributions have been made to this end by the United States Geological Survey. Burbank in his geological studies of the San Juan region has worked out the vein pat-

Region of the Shenandoah-Dives mine, Colorado

terns and the relationships of ore shoots to them. Koschmann has done the same thing in Cripple Creek, Lovering in Boulder County and elsewhere, and several other members of the Survey have contributed similar studies to various districts. This, the broad study of any given area, is the vital first step in the direction of scientific ore discovery. When this information becomes generally available and properly understood it will be interesting to see if the industry can organize itself properly to apply the knowledge in such a way as materially to increase the ore reserves of the nation. Then in times of National Emergency we shall continue to be able to meet extraordinary demands, without costly and dangerous delays.

Ore Search in the TRI-STATE District



By GEORGE M. FOWLER
Consulting Geologist
Joplin, Mo.

THE Tri-State District comprises an area of about 2,000 square miles and the production from its discovery in 1848 to date approximates $950,000,000. More than 75 percent of this production came from intensely deformed areas aggregating 30 square miles—10 square miles around Webb City, Mo., and 20 square miles around Picher, Okla. The remainder of the production came from innumerable mineralized areas ranging in extent from a few square feet to several hundred acres scattered throughout the district.

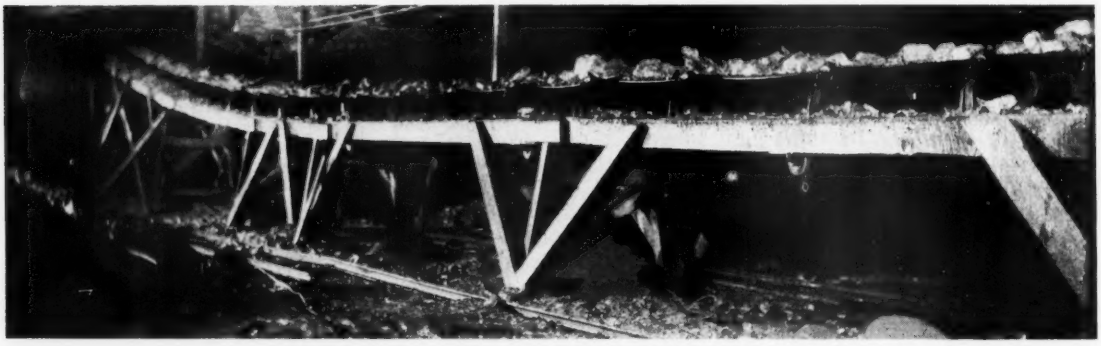
The important ore discoveries of recent years have been confined to the region around Picher. Elsewhere a few widely scattered ore bodies have been found in the many square miles that have been prospected.

The ore deposits of the Tri-State District are localized almost entirely in limestone and chert strata of Carboniferous age. The early discoveries were made from surface outcrops and excavations. The first ore in the vicinity of Picher, Okla., was discovered in 1915 in a churn drill hole at a depth of about 250 ft. Many thousand additional drill holes were completed in order to delineate these ore bodies. The ore-bearing horizons around Picher are concealed by from a few feet to more than 200 ft. of younger strata, principally Mississippian limestone and shale of Pennsylvanian age.

After 1925 much greater attention was paid to structural deformation and its influence on the localization of these ore bodies. Gradually it became evident that the detailed stratigraphy of the ore-bearing horizons could be determined from the churn drill cuttings, and structural contour maps showing vertical intervals of 5 feet were prepared. These maps now cover all the region that has been prospected; data obtained from more than 40,000 drill holes were used in preparing them. The maps give definite clues as to the ore-bearing possibilities of many large areas in this district. The usual method is to space holes one-fourth mile apart and drill through the ore-bearing horizons which range from a few feet to about 400 feet in depth. Many tracts have been eliminated as barren by this amount of drilling. If the structural maps indicate possible ore bodies they are delineated by additional drilling. In all cases the ore is confined to the zones of adjustment and is closely related to the favorable strata within them.

Zones of intense deformation where the deformed and shattered strata moved from a few inches to several feet instead of many feet were particularly favorable ore reservoirs. Structure displacement of many feet generally lacked intense shattering and opening of beds which are so essential to localizing ore bodies.

The principal factor responsible for discoveries in recent years in the Tri-State District is a better knowledge of the close relationship of ore deposits to structural deformation. Others engaged in ore search in many widely scattered districts throughout the world have long recognized this relationship and applied the observations successfully in their respective districts.



Transporting ore rock by belt conveyor, Tri-State district

New Developments in Ore Discovery in MONTANA and NORTHERN IDAHO

By

JOHN EDGAR
Chief Engineer

NORMAN M. SMITH
Chief Geologist

Sunshine Mining Co.

THE authors of this paper acknowledge their indebtedness to John M. Conrow, of Montana School of Mines, for the preparation of that part of the paper dealing with the State of Montana.

Although the Montana miners cannot point to any significant actual new mineral discovery made during the past ten years or so, they have founded, and are building, new and vitally important industries upon discoveries made years ago. These new industries which now utilize long known but previously non-productive mineral deposits are parallel in interest and significance to new mineral discoveries. They are as definite and valuable an addition to State and National economy as a new discovery.

Defense Needs Have Stimulated Production

Factors responsible for the development of the new and relatively new industries vary. Chromite and manganese production stem from wartime necessity as do increased zinc, tungsten, and copper production. Talc and vermiculite mining are normal industrial developments although they will no doubt be at least temporarily stimulated by the wartime industrial boom.

Currently the most publicized of Montana's mineral resources are the chromite deposits of the Stillwater Complex in Stillwater and Sweet Grass Counties, and of Line Creek and Hell-roaring Plateaus in Carbon County. During 1940 and '41 the chromite deposits of the Stillwater Complex have been studied by the United States Geological Survey and an extensive program of diamond drilling and sampling has been carried on by the U. S. Bureau of Mines in the Benbow and Mouat properties east and west of the Stillwater River, to determine tonnage and grade of ore available. This work indicates one to two million tons of 25 to 30 percent Cr_2O_3 ore in widths of 4 to 5 ft. in the Benbow property, and a similar tonnage and grade in somewhat greater widths in the Mouat property. The U. S. Geological Survey in Bulletin 922-N expresses the opinion that ". . . it (the chromite) would continue to any mineable depth." Plans are being pushed for the production of chromite concentrate from ore from the Benbow property by the Anaconda Copper Mining Company on Government account. A 400-ton concentrator is being built and the deposit is being prepared for mining.

The long dormant manganese mining industry in Butte has been revived with the reopening of the Emma mine, and the construction of a concentrating and nodulizing plant in Anaconda. Manganese carbonate (rhodochrosite) ore is mined from the Emma mine in Butte and is concentrated and roasted to produce black manganese oxide in Anaconda. The operation is being conducted by the Anaconda Copper Mining Co. One thousand tons of rhodochrosite ore are mined daily in Butte, from which 350 tons of nodulized manganese oxide are produced by the plant.

Production of the tungsten mineral, scheelite, has for the past several years been an increasingly important by-product of the gold mining operations at Jardine in Park County. Recovery for 1940 was 60 tons of concentrates containing 65 percent WO_3 as compared to 20 tons for 1939. 1941 production will no doubt exceed that for 1940 as the recovery of scheelite is being emphasized. The mineral occurs in association with the gold-bearing quartz veins and was probably discovered in the process of treating the gold ore.

In Northern Idaho there are two districts in which significant developments have taken place in the last ten years. They are the Silver Belt of the Coeur d'Alenes and the Yellow Pine District in Valley County.

Yellow Pine District Becoming Important

The Yellow Pine Mining District is fast becoming one of Idaho's major mining districts. This is particularly true since the strategic minerals program has been put into effect. Discovery in the district dates back to the turn of the century, but only in the last decade, when the late F. W. Bradley organized the Yellow Pine Mining Company which began operating in 1932, has the district come to the fore.

Operations began by conventional underground methods in the Meadow Creek Mine where two types of ore occur—gold-arsenophyrite of earlier origin and the later stibnite ore. The ore shoot was bottomed against a fault at the 422-ft. level after producing 275,654 tons of ore from which about 60,000 ounces of gold were extracted. Antimony averaged 2 percent or a total content of around 5,500 tons of metallic antimony.

In 1938 the Bradley Mining Company turned to the development of the neighboring Hennessy ore bodies, now known as the Yellow Pine Mine, with modern excavating and hauling equipment, power shovels, trucks and their auxiliary equipment. The ore has been produced from two quarries known as the East Quarry and the West Quarry. The metal sought and recovered is gold. Five hundred (500) tons a day are milled with mill heads averaging approximately $5.00 a ton.

Mineralization of the ore body is primarily gold bearing pyrite and arsenopyrite disseminated through an altered granodiorite-aplite. Stibnite is found in the west section disseminated through the ore and in high-grade veinlets.

Several miles to the northeast on the projected extension of the Yellow Pine Mine deposits, only antimony mineralization is found. On these deposits in 1939 the U. S. Bureau of Mines began its investigation of the stibnite bodies by stripping the surface with bulldozers and outlining the bodies by diamond drilling. It was in connection with the drilling exploration of

the antimony bodies that the most important discovery of the decade, and perhaps of the century, was made. Examination of the drill cores by Dan E. White, geologist for the U. S. Geological Survey, revealed the presence of another strategic mineral, scheelite, an important tungsten ore.

Full dimensions of the tungsten ore are not known. The Bradley Mining Company began exploring the body early in 1941, by sinking a 162-ft. shaft from which a crosscut was driven, with the intention of getting under the ore body, only to find that they had run "smack dab" into an unexpected downward extension of much higher grade material. Without abandoning conservatism, the Yellow Pine ores may prove the largest known body of tungsten in the world.

Developments in Silver Belt of the Coeur d'Alene

Of chief interest in North Idaho, during the past decade, have been the developments within the Silver Belt of the Coeur d'Alene District. The most spectacular of which has been Sunshine Mining Company's operation on Big Creek. Here, after years of a "hand to mouth" existence, was developed the largest silver mine of United States, producing, since 1930, over seventy million (70,000,000) ounces of silver.

The Sunshine, like other mines of the Silver Belt, cannot be termed a recent discovery. It was originally located in 1884, but only since 1930 has production become phenomenal. Large scale production began only after a rich bonanza ore shoot was developed below the 1,500-ft. level. Credit for this kind of development lies in the faith and perseverance of the early management and the lack of present day governmental regulation and taxation which would discourage the necessary investment of capital in that type of venture.

Because of the phenomenal ore shoots which have been developed in the lower levels of the Sunshine, chiefly from the 1,700 level down, other properties in the Silver Belt have been encouraged to attempt deeper exploration. The ore of the Silver Belt consists of silver-bearing tetrahedrite in a quartz-siderite gangue. The quartz-siderite veins persist to the surface but the tetrahedrite occurs in shoots along these veins at a considerable distance below the surface. Thus, any quartz-siderite vein within the known productive area becomes a potential ore-bearing vein at depth.

In a raise, Butte mine

The Polaris mine, immediately adjacent to the Sunshine on the east, now operated by the Hecla Mining Company, has an even earlier history than the Sunshine. Stimulated by the deep level developments at the Sunshine, it has been developed to the 2,300-ft. level and mining is in progress at the rate of 250 tons per day. Two miles east of the Polaris, the Coeur d'Alene Mines Corporation has, within the last few years, explored at depth and are now mining from the 1,000-ft. level downward at the rate of 300 tons per day and is planning to increase the mill capacity to 500 tons per day. Both of these properties have lately been developed into producing mines by exploring at depth veins and structures known to exist for many years but which were non-productive on the upper levels.

As a by-product of silver in this area, there is being built up what is another of the largest reserves of antimony in the nation. Antimony production from the Coeur d' Alenes in 1940 equalled approximately 1,350 tons and 8,000 tons for the last ten years. Copper, too, is an important by-product in the silver ore. Seventeen hundred (1,700) tons were recovered last year. None of these veins could be mined for their copper and antimony alone, but mined as a by-product of silver they furnish a valuable contribution to our national defense.

Factors in Ore Discovery in the SOUTHWEST

By R. S. BUTLER
Professor of Geology
University of Arizona

I SHALL emphasize the place of geology in the discovery and development of ore deposits but without minimizing the help of improved physical means of determining some of the geological facts.

The prospector is obviously a geologist, or an applier of geological principles, and prospectors have ever been eager seekers after new geological facts and principles to apply in the search for minerals. The prospector has followed close on the heels of the geologist in application of geological principles whether he be the prospector of the burro period, the model T period or the airplane period. Theories of ore deposition have changed and improved in the last two or three generations as much as have the means of transportation of the prospector but some of the early theories are as sound and useful as they ever were, as is also the burro still useful in his proper place and sphere.

The interpretation of outcrops has been of large importance in the development of the copper deposits of the southwest. The idea of secondary sulphide enrichment, due to weathering,

became a workable theory with the turn of the century and has been a guide in the development of these copper deposits. It, however, was not full grown and perfect at the start and has been modified and improved.

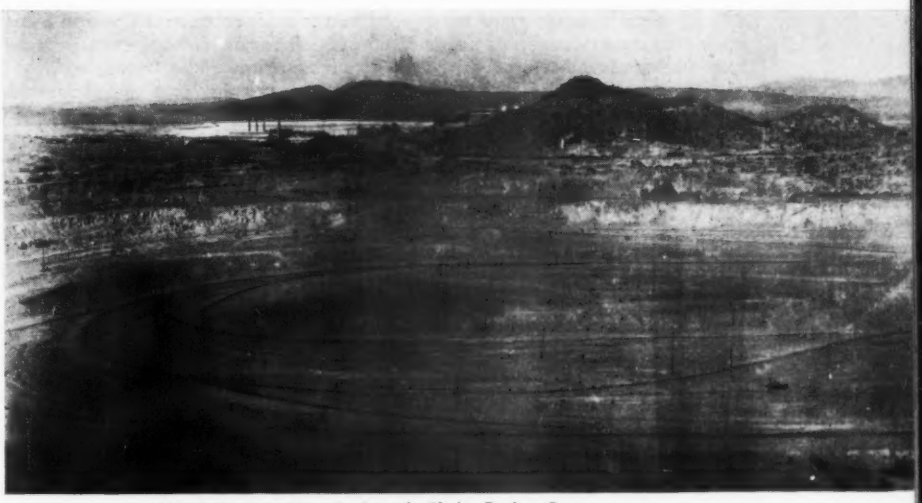
The simple conception of a highly leached surface zone underlain by a zone of enriched sulphide and this in turn by a zone of lean primary ore exemplified in the disseminated deposit of Morenci has required modification to little surface leaching, little sulphide enrichment and no sharp change in metal content between the zone of oxide minerals and sulphide minerals, exemplified in the limestone deposits of Bisbee and the disseminated deposits of Ajo, though at Ajo structural changes have also been a factor as pointed out by Gilluly. Other districts are intermediate, as the Miami District, which has both enriched sulphide and enriched oxide zones.

The idea that the water table controls the secondary sulphide zone may be generally sound but in the Southwest the changes in position of the water table have been such that there is now little relation between water table and ore zones.

Some mineral deposits as coal, gypsum, and placer gold were formed at the same time as the enclosing rock. Prospecting for them is based on the conditions of sedimentation that favor the formation of such deposits. Other deposits are later than the enclosing rocks as fissure veins, and prospecting is based on favorable structure and other relations.

"Red Bed" Deposits Usually Do Not Bear Close Relation to Recognized Structures

Certain deposits, notably what are known as the "red bed" deposits of the Southwest are not so easy to classify. They include copper deposits, silver deposits, uranium-vanadium deposits and manganese deposits. Characteristically they are lenticular bed deposits of limited extent though there are associated fissure deposits. Most of the deposits occur at a few rather definite and restricted horizons and most of them do not show close relation to recognized structures. Discovery has been mostly from outcrop though extensions of mineralized areas have been developed that do not outcrop. Over large areas the favorable horizons are buried and search for the deposits must be based on some theory of origin, as favorable conditions of sedimentation or favorable structural conditions. A considerable literature has been built up on these deposits but no generally accepted theory of origin has emerged. A clear understanding of the origin of this type of deposit will add much to the effectiveness of prospecting.



Pit of the New Cornelia branch, Phelps-Dodge Corp.

A major feature of the Southwest is the relatively undisturbed block of the Colorado plateau surrounded by a belt of intense folding and faulting the formation of which was accompanied by the intrusion and extrusion of vast quantities of igneous material that now forms a broken ring of igneous rocks around the plateau. The ore deposits in this belt make it one of the great mineral provinces of the world. The structural and igneous activity probably began with laramide time and continued, perhaps, to the present. It may be noted, however, that the pre-Cambrian deposits of the region are also in this belt. The location of some of the districts within this belt is determined by structures that cross the main belt as the Front Range mineral belt of Colorado, the Park City-Cottonwood-Bingham mineral belt of Utah and the Globe-Miami-Superior mineral belt of Arizona. It is probably needless to say that the structural control of many districts within the belt is not yet determined.

Knowledge of Structural Control in a District Is Important

The structural control within the district is the most direct and obvious aid in the search for ores. It is preeminently the field of the company geologist or engineer who is directing the search for ore. Each district and to some extent each mine is a problem in itself. It is obviously not possible here to discuss all the different problems. Detailed mapping has come to be recognized as the first essential in understanding detailed structure. Harrison Schmitt in numerous papers has set forth effective methods to be applied in mapping and the results to be expected. Three dimension models of mines and of districts are most helpful in complicated areas.

Structures range from relatively simple faults or fissures, as the Magma fissure, to complex patterns of folding, faulting and fissuring represented in the Bisbee and Tombstone Districts of Arizona, and the Hanover District of New Mexico.

Perhaps the most productive structural type of deposits of the southwest, and possibly as little understood as any, is the ore stock, ore pipe, or ore chimney, that has yielded much of the copper as well as other metals. These are bodies of mineralized fractured or brecciated rock with more or less circular or elliptical outcrops. Many are near the roof or apex of intrusive bodies that rose near enough to the surface so that failure of the rocks resulted in brecciation rather than in shear. Some are mainly or entirely within the intrusive rock, others mainly in the intruded rock. In most of them the productive zone is not deep and the deep zone has not been extensively explored. This in part accounts for the lack of facts concerning them that permits of a clear understanding.

Two of the relatively recently developed large ore bodies of the southwest, namely, the Campbell ore body of Bisbee and the Colorado ore body of Cananea are of this type as is also the deposit at Morenci. A smaller deposit recently developed is the

Childs-Aldwinkle molybdenum-copper pipe of Copper Creek, Arizona. The very extensively developed United Verde pipe of pre-Cambrian age of the Jerome District has been described by Reber and others.

The association of mineral deposits with intrusive rock has long been recognized as helpful in prospecting. The large ore deposits of the Southwest are associated with intrusive bodies of relatively small outcrop and of intermediate composition. The very large intrusive bodies of granitic composition and coarse texture usually have only small associated deposits.

It has long been recognized that ore deposits are grouped in and about the tops of intrusive bodies notably about the apex of stocks or the high points of batholiths. Where erosion has cut deep into the stocks the associated deposits have been removed. Recognition of this relation has been helpful in selecting regions favorable for prospecting rather than in the details of prospecting.

Study of the outcrop and interpretation of what to expect below guides the prospector in the first stages of prospecting. The question of where to stop must sometime and somewhere be faced. Its proper determination is second in importance only to the first step of where to start. It is easy to spend profits in a search for extensions that do not exist and it is perhaps equally easy to miss rewards by stopping too soon. The matter of where to stop should not be based on optimism or pessimism of the individual but on an appraisal of geological conditions. The early operator who could successfully treat only oxidized ores knew that his mine was bottomed, for the time at least, when he struck sulphides.

The improvements in the mechanical means of prospecting can only be mentioned here, but its importance is large. The diamond drill and churn drill have played an important part. Geophysical means of determining geological relations have not yet been as effective in the metal district of the Southwest as in some other fields but is worthy of development. The violet ray lamp has led to the discovery of numerous scheelite deposits some of which may prove productive. In mapping, the airplane and photography have been recent aids.

Discoveries Are Lacking in New Districts

From pioneer days to the present there has been a steady drop in the curve of discovery of new districts and new deposits. Over the same period there has been a steady rise in the curve of mineral production.

This means that production has come increasingly from extensions in known districts and of known deposits. For the past decade it is difficult to point to a really new discovery of major size. Extension of known areas and development of known deposits has kept up the producing capacity. An outstanding example of this in the southwest is the Morenci open pit mine about to come into large production though long known and awaiting the proper time for development. Similar extensions and developments in mining districts have kept up the producing capacity.

Lessons of the Past Must Be Applied to the Future

The problems of future discovery seem, in principle, the same as those of the past. A clear understanding of the character of the ore deposit must be had before prospecting and development can be planned to the best advantage. In the past the broader features both in geologic relations and in mineralogy have been the field of governmental surveys, university faculties and research laboratories. The application of the principles has been the field of the company geologist and engineer and the consultants. It is probably needless to add that this distinction has not been sharp. Company geologists have contributed largely to theory and Government and university men have participated in application.

All fields are still open, past mapping is a vital help to present work and furnishes facts for broad correlations, and interpretations. The same is true of mineralogical and chemical studies.

If an intensified industrial age is to be supplied with mineral products, not to mention a war-ridden world, all the fields must be developed intensively. As George M. Fowler has recently stated future prospecting "will combine the effort of geologists, geophysicists, geochemists, and others who have a knowledge of ore deposits together with the equipment that may be developed for their use."

Trends in Ore Geology

A YEAR ago, MINING CONGRESS JOURNAL published a debate on the effectiveness of mining geology, in which R. H. Sales took the affirmative and I. B. Joralemon took, in a sense, the negative. These gentlemen represent contrasted departments of discovery method. Sales has led the way in perhaps half the mine mapping done in the West. Joralemon, with a similar aim, has used different devices, de-emphasizing mapping, though not dispensing with it, and stressing personal judgment and activity. He advocates what amounts to old prospecting refined by advanced engineering practices of surveying and sampling.

By AUGUSTUS LOCKE
Mining Geologist
Menlo Park, Calif.

The prospecting method, in its elemental form, was the means of all the primary discoveries of the West. In the early times it was primitive, emotional, personal, and adorned with romance, and it could afford to be so, for crowds of fine ore bodies were waiting at shallow depths to be discovered. In its refined form this method is still having successes, such as the United Verde Extension, Mountain Copper and Getchell ore bodies; but these, as everyone knows, make a small and dwindling company compared with the past. Joralemon believes, nevertheless, that

this, essentially, must remain the effective method. The environs of ore are but imperfectly understood and he expects them to remain so. He clearly expects no such development in the art of ore discovery as has taken place in oil.

In this conclusion Joralemon is drawing a chart of future mining geology. Others, including Sales, draw charts of quite different kinds, all based on the experience that any method used is effective in proportion to the completeness of its information. According to these other charts, the art of exploration piles fact on fact until questions answer themselves. The present practices of mapping, intensified, can unravel the ore structures; expanded, they can seek and identify explorable analogues. The idea of the Gordian snarl to be cut with a knife is emphatically refused.

In practice, one or the other of these opposed philosophies rules, and the actual procedures are astonishingly spotty and varied. Discovery has been recently, and still is, accomplished by all the methods, old and new—some without benefit even of surveys, and some with all the technical guns which can be brought up; some with able leadership and some with none. But this does not tell us where we are going. What we must know is the trend, and which side is building up; for we cannot expect the future to reproduce the past.

What Are the Trends in Geologic Examination?

I shall therefore use the opportunity in this number of the Journal to look at recent discovery for signs of this trend. But in order to forestall disputes about meanings, I shall first set down a definition of *geology*. Several items of discovery practice are not to be considered geology. Prospecting is not geology, nor is trading, nor shrewd intuition of the ground, nor superintending the mine. The geologist may do all these things, but they can be done also by those who are not geologists at all. What then is the mark of geology? Whether in ore or in oil, it is expressing the facts of mineral occurrence in their three dimensional relations. In other words, the geologist collects information and constructs what amounts to a model of the ground. This he does by making a geological map; practically, if there is no map there is no geology.

Under this definition, how far has geology counted in the recent ore discovery? In new districts, the record powerfully favors prospecting; for, while that method has lately had a few successes, geological maps have had none. Had no such maps been made, not one of the primary discoveries would have been missed, from the beginning of Western mining to the present day. In contrast, the principal oil locations rest squarely on the map, strengthened in late years by seismic and gravity readings. Oil mappers have gathered millions of data, covering whole States in a vigorous search for new structures. Of such an activity, ore has only the beginnings, in the district maps of the Federal and State geological surveys. The industry itself is not yet, by comprehensive mapping, hunting around for new districts; and anyone suggesting to a company president an oil type of campaign would do so at his own, well merited, risk.

The next smaller scale of discovery, that of the detached ore center in the old district, has usually during the past two generations had the help of some kind of district map. The maps available vary from flat sketches of rock pattern to the amazingly elaborate, three-dimensional compilations of the Butte District, based on no less than a million observations taken to the depth of a mile. The differences respond, of course, to differences in the problem. But they respond also, and perhaps in equal degree, to the geologist's and manager's idea of what the problem is and how it can be solved. For example, a few years after the Great War, the Cananea District suddenly came out with the turnip-shaped Colorada ore body, 500 ft. wide and 1,000 ft. high, hidden 500 ft. deep below the surface, inside a halo of disseminated ore. This ore body, containing as much copper as had been mined in 30 years from the whole four-mile length of the district, appeared with no more notice than a meteorite plowing into the ground from the sky, and was followed by careful maps of the whole district. But, though similar roots were suggested in other districts, the owners of these districts have not yet had to make the systematic maps on which such roots might be located. The problems of these districts, mechanical and metallurgical, have provided only mild incentive toward researches in exploration.

District Maps Have, in General, Followed Developments

The district maps fit for guides to new ore centers have, with a few recent exceptions, followed rather than preceded development. Thus the Tintic maps, previous to the revelation of the Tintic Standard ore body two miles east of the working ground, were little more than sketches giving not a whisper of ore bodies there. In fact, much of this part of the district was still open to location, and the new ore was found, not by one of the strong old companies of the district, but by a persistent, daring prospector not associated with those companies. As in Cananea, the discovery was followed by high quality maps which spread far out into new ground.

This has been the order of events in many districts. The practice has been to express the facts revealed by exploration, rather than to present in advance an analytical picture to which expectable ore centers could be referred. With the few recent exceptions, the extension of ore districts into new ore centers stands in sharp contrast to that of oil districts, where the ground is always exhaustively mapped ahead of the drills.

Exceptions to the Rule Are Few

In any appraisal of the trend, however, the recent exceptions, which affect no more than 1 percent of current production, are in my opinion critical. After the Tintic Standard the maps showed up a framework of fissures, thrust faults, layered rocks, intrusive rocks, and alteration, into which the new ore was seen to fit, and this led to analagous structures in which were found, by oil-type explorations, the North Lily and several other ore bodies, deeply hidden away. Similar experiments in Butte, Cananea, Hanover, Hedley, and a few other districts reveal the clear beginnings of an ore exploration paralleling that of oil.

The ore geology is of course smaller, more intricate, and expressible only through many times the density of observations. We can understand why when we recall that oil comes in moderate structures of layered rocks, while ore, especially the center from which it spreads, comes in tangles like those of metamorphic rocks, more often than not made the more baffling by intrusive rocks and alteration. The question, in what degree such tangles are hopeless and in what degree they can be practically understood like the smoother structures which carry oil, will be answered only by experiment. A contrast between the maps of Lead, S. Dak., and those of the Mother Lode of California will illustrate the truth of this statement. The Mother Lode,

which lies in metamorphic rock, has never been so mapped that a structure presumptively carrying blind ore 500 or 1,000 ft. deep could be pointed out. Only district rock maps on a tiny scale have been available, and on them the individual mines, so far as unique structures are concerned, might as well be at one place as another. It has long been supposed, and is still supposed, that no pattern sharply significant of ore could be worked out in this kind of rock, and the mining companies have made no attempt which I have heard of to experiment with any such pattern. This same idea in regard to seeking a pattern in metamorphic rock has pervaded the studies in other Western districts such as Bisbee, Jerome and Miami. But meanwhile, in Lead, beginning with Sidney Paige, of the U. S. Geological Survey, in 1911, a beautiful practical pattern has been worked out in just this kind of a tangle. No one predicted, or would have been able to predict, the effect of thousands of observations on mining inside this tangle. However, once the system of observations was established, the structure visibly and progressively clarified; the place of the mineral is now as definitely understood as in an oil structure, though twenty times the information is needed for practical purposes to make it so.

More Impressive Role for Geology Is Badly Needed

The operating, routine, problems which so occupy ore geology at present grow heavier as the mines go deeper, and, not only development of ore in the producing mine, but also breaking and holding of ground, will increasingly use the geologists knowledge. But a greater and more impressive role is already being demanded. The mining industry, which has already skimmed the cream of shallow discovery in the West, will be forced to find, hidden ore, economically, as deep as a mile below the surface, on structures recognized at the surface itself. I have no doubt of coming tools for getting thus deep into the ground, or twice as deep when that becomes necessary, which will excell those we now have. But for the guidance of these tools, the practices of the past will not be enough. It will not be practically feasible to riddle blocks of ground to any such depth as this in the search for such needle-sized objectives as ore bodies, no matter how smart the director may be. No such enterprises can depend on individual genius; they will have to incorporate forces of workers, organized according to successful practice; for the quantity of information needed is many times too large to be put together in any other way.

How far such adventures will go, no one can say, for no one knows how much metal is left in the ground. But the expectation of such metal is such as to enforce deep searching in which the geologist will have to perform feats the contemplation of which at this moment would startle both the mine president and the geologist himself.

Factors in Ore Discovery

By RENO H. SALES
Chief Geologist
Anaconda Copper Mining Co.

THE Butte District has not been mentioned in these papers. There, as in regions and districts described by Landwehr and others, a comprehensive understanding of the geology is the basis of ore discovery. The significant geological factors made particular use of in the search for ore are: mineralized fissure system and their age relations, vertical and lateral mineral distribution, or mineral zoning, rock alteration, and directional trends of ore zones. In this category of discoveries I do not include recovery of faulted vein segments or extensions of known ore shoots.

It is not easy to place correctly the credit for an ore discovery in an operating mine. Direct responsibility is sought when a prospect crosscut strikes ore. It might be said, with good reason, that a particular discovery would have been made in the course of normal mine development and without advice from the geologist. I think most mine operators will agree that credit should be given where the discovery has been made through strict application of geological fact and theory whether supplied by geologist or management. Under that interpretation at Butte, recommendations of the geological department have resulted in the finding of many important orebodies, exclusive of recovered faulted blocks and segments of veins and ore extensions.

Cooperation Between Geologist and Mine Management Is Important

I desire to call attention to another factor of great importance leading to ore discovery, as true elsewhere as at Butte. The mine geologist must have the full support of management and those in direct charge of underground operations in the mines. It is a pleasure to report that at Butte and in other districts where Anaconda operates, the geologists have received that needed help and cooperation.

The outstanding fact brought to our attention through these various papers is, that a comprehensive knowledge of geology has been a vitally important element in the planning of mine work which led to many of the more recent discoveries in operating mines, and in developed districts. The reasonable conclusion is, that with increasing knowledge of mine geology comes greater opportunity for ore discovery.

I believe that there exists in the minds of many operators some misconceptions concerning the objectives of mining geology, both as to discovery of ore and use of geology as an aid to mine operations. Mr. Wade says, "After all, ore-bodies are found by chance." One can truthfully say that in every field of scientific endeavor, many discoveries are made by chance, but who will deny the wisdom of the

maintenance of large research departments by large oil companies and many of our largest manufacturing concerns? Their records speak for themselves. The research men so employed do not "see into the future," neither does the mine geologist "see into the ground," but the founders of elaborate research departments have had at least two laudatory objectives: that of eliminating, or reducing as far as possible, the element of chance; and clearing the way for future discoveries through the full use of available information. In an industry such as mining where individual mines, or units, are rated normally as hazardous enterprises from inception to old age, it is common sense that every effort be made to lessen risks and to provide for future existence. Correct understanding of the geology of the mines or units in question must form the basis of such effort. The mining industry must not trail its contemporaries in the important matter of research.

The question has been raised by Mr. Locke whether any orebodies are found through application of geological principles. It is a broad question. Most exploratory work done in the search for ore is based upon theory. Even the lone prospector uses geological reasoning for guidance as he works in shaft, drift or tunnel. It is his incentive to continue in the hopes of striking pay ore. When success crowns his effort no one can say his discovery was made entirely by chance. I have already said that in Butte numerous discoveries have resulted from work done based upon theory. A mineral discovery in a well drilled for water without reference to geology or possible ore occurrence, is a "chance" discovery, but a far cry from one made in undeveloped ground through intelligent use of available geological information.

Metal Resources Rapidly Being Exhausted

Again let me call to the attention of the Mining Congress the rapid exhaustion of our known metal resources. Everything possible must be done to meet the situation. Field search for ore by old time prospecting methods is at a standstill. Little development work is being done at the present time by prospectors holding claims who appear to have reached the limit of their ability to find ore. He awaits the coming of a buyer. The active type of prospector who roams the hills in search of vein or outcrop is today an uncommon sight in these United States.

New Type of Prospector Needed

I believe it reasonable to predict that in the future important discoveries will be made by a new wave of prospectors, having a working knowledge of the geology of ore deposits. By "prospector" I mean one who travels on foot or by burro, armed with pick, shovel and pan, as in former days, but his equipment must include also, the compass, tape, notebook, and available geological maps or other publications covering the area in which he operates. Of necessity he must have the ability to identify the common minerals and rocks, and to map and interpret geological structures.

The "prospector" above-mentioned will need financial backing and he will get it if he and those who try to develop our natural resources receive encouragement from our Government. More lands in possible mineral regions are being withdrawn and made into parks for the tourist. Forestry and land departments are bearing down harder, and it is becoming more and more difficult for the prospector to get title to mining claims. Taxes are taking the cent out of incentive. The unpaid-for new mine is taxed as heavily on income as old established operations. Much of the expected net return of money contained in developed ore reserve at the time of purchase, and which forms the basis of the purchase price, goes for taxes, thus providing a new high in the curve of mining uncertainties. The SEC is delivering knockout punches to budding companies trying to find mines. An about face in governmental policy is necessary if our mining industry is to survive.

The Human Element in Finding Mines

By JAMES W. WADE
Vice President
Tintic Standard Mining Company

THE geologists in these discussions have stressed their art, but one thing stands out clearly from all the papers; that is, despite the progress in geological mapping and deductions, chance is still the major factor in ore discovery. This is so because an ore body is a freak of nature, something like a six-fingered child. If you had to find such a child you would carefully examine all the children born in a large hospital, and so to find ore bodies your best prospecting is in known mineral areas.

The reports of the geologists clearly demonstrate the dearth of new mines. Most of the mines of the Rocky Mountain areas were found in the years following the Civil War, because at the close of that war we turned loose a great number of men who were filled with the spirit of adventure, inured by the struggle of war to hardship. These men spread over the area in a short period of time and found practically all the great mining districts.

I have been fortunate in having had the opportunity to have seen three new mines discovered. I mean mines such as Mr. Sales refers to, where there were no known ore bodies near by, although in well known districts. It has also interested me to know why each particular area was picked out by the prospector.

I went to the Tintic Standard Mine in 1907 and listened to the reasoning of the practical miner who was a geologist, as Mr. Butler describes a geologist, but not as Mr. Locke describes

one. Captain Raddatz had the one thing that all prospectors need, and that is sufficient confidence in his deductions and theories to warrant his spending the money and time necessary to find the ore. I remember his going over the surveys of the ground telling me why he wanted to spend the money in that area. He took some of the outcroppings of low-grade quartz and panned them and found the concentrates carried 30 to 40 ounces of silver. He developed the theory of rich solutions going through the limestone and believed he would find an ore body by developing the property. He went as directly to that ore body as any geologist could have done, although there was no geological mapping. The one characteristic that stood out was the spirit of adventure and the necessity and willingness to take a risk.

The other two mines were developed on theory as determined by geologists, by careful geological surveys and drilling, as was the North Lilly Mine, but there again you had the same element—someone had to have the courage to carry on; the spirit of adventure provided the urge to do the work and spend the money necessary to find the mines.

I am going to tell you one story which was told to me by Will Knight whose father founded the great group of mines developed by that family in Tintic. I sat on the dump of the old Humbug Mine when he told me the story. He said, "We found this ore body because we were poor farmers and saw a lot of money being made by mines. My father said he was going to get a mine, get a piece of ground cheap. So he located a piece of ground in the Tintic area as near to the big mines as he could and he wandered around over the surface trying to see the similarity of the outcrops in this ground and the neighboring ground. In the course of his wanderings he got tired and went to sleep; he dreamed that he saw a white horse wandering along the hills and this white horse wandered over from the June Bug to the Humbug claim and stood there. As he continued to dream, the earth opened up and below, under the white horse, was a great ore body. He awakened and said, 'She has got to go under that tree.' We drifted under the tree and found the great Humbug ore body."

That story seems amusing, but it illustrates my point. The willingness to venture money and lives to find ore bodies has always been necessary.

So the geologist when he propounds a theory—as Mr. Sales said—"finds that is when his trouble begins," but really it is when the troubles of the management begin. Management and capital after all, take the risks.

If we in the United States continue to have commercial ore bodies which we so much need we must instill in our people the spirit of adventure and maintain that spirit.

The important lesson from this discussion is that capable, experienced geologists create the foundation upon which an enthusiasm can be built that stimulates the spirit of adventure to the point where actual development work is done.

Eureka Standard mine in the Tintic District

Property or Materials May Be Requisitioned for War

An inventory and requisitioning section in early December was set up in the OPM to provide for prompt acquisition of war materials whenever normal sources of supply are inadequate.

The new section will administer the power to requisition materials and supplies as provided in the Executive Order of the President issued November 19, 1941, providing for the Administration of the Requisitioning of Property required for National Defense.

Through the section established, OPM may requisition materials directly or may review and approve requisition orders issued by other Government agencies.

The requisitioning procedure will not be used to interfere with control over the flow of materials to war and essential civilian industries by the priorities system, but will supplement the priority system whenever priority orders are insufficient to get essential materials to the right place at the right time.

The inventory and requisitioning section will be in the Priorities Division of OPM. E. A. Tupper will act as chief of the section, under the general supervision of L. J. Martin, chief of the compliance and field service branch.

To facilitate the work of the new section, the survey of existing inventories of scarce materials which has been undertaken by the industrial branches of OPM will be speeded up, and inventory control will be tightened all along the line.

Priorities Regulation No. 1 provides that inventories must be kept down to the minimum practicable working level. This regulation will be strictly enforced. Hoarded scarce materials will be requisitioned as needed.

Domestic Mica Produced

Mica from Spruce Pine, N. C., mines is helping to fill the shortage created by curtailment of imports from India. Following investigation by the United States Geological Survey, the U. S. Bureau of Standards has placed its stamp of approval on Spruce Pine clear sheet mica for such exacting uses as radio condensers.

In the Spruce Pine area, mica and feldspar have been mined from more than 500 pegmatite bodies distributed over 250 square miles. Some of the bodies are more than 100 feet thick and occur both in alaskite and adjacent metamorphic rocks. It is estimated that 16,000,000 pounds of sheet and punch mica have been shipped from this region since 1868 when mica mining was begun here, and current annual production of clear sheet mica is about 50,000 pounds. Producers are of the opinion that it may be doubled if the expected demand develops.

Magnesium By Electrothermic Reduction*

One of the important parts of the war effort is the vastly expanded production of magnesium metal. The U. S. Bureau of Mines at the Pullman, Wash., station attacked the technical problems of production of this metal at a most opportune time, in 1936, and have carried through to the pilot-plant stage investigation of processes to utilize the plentiful resources of the Northwest.

Mr. Doerner here describes the work that has been done and the process that they have evolved.

By H. A. DOERNER
Metallurgist
Metallurgical Division
U. S. Bureau of Mines

THE Bureau of Mines began to study methods for producing magnesium metal at Pullman, Wash., in cooperation with the State College of Washington, early in 1936, long before the present urgent need for a large increase in the production of this metal was anticipated. This investigation was not initiated because of any apparent deficiency in the quantity of metal produced or a lack of efficient methods of production adapted to abundant raw materials. This program was prompted by a desire further to develop industrial utilization of the natural resources of the Northwest and provide an outlet for power generated at Bonneville and Grand Coulee dams.

Washington Has Important Magnesite Resources

The State of Washington has important magnesite deposits, from which a large part of our domestic production of magnesia refractories has been obtained. Since the World War of 1914-18 the annual production of crude magnesite has averaged nearly 200,000 short tons, mostly from Washington deposits. The calcined product, "dead burned magnesite," normally sells for less than $20 a ton. One ton of this calcine contains 960 pounds Mg, having a market value of about $260. Hence, the production of magnesium metal from this abundant raw material seemed to offer an excellent opportunity for a new metallurgical industry in the Northwest. Despite the astonishing margin between the market value of magnesite and of the metal that can be obtained from it, economic utilization of magnesite as a source of metal presented unsolved problems, as was evident from the history of the industry.

Preliminary Investigations Were Conducted

After a study of the literature relating to this problem, the following conclusions were stated in Bulletin P of the State College of Washington, "Magnesium," published early in 1937. "On the basis of information now available there are just two methods by which it may be profitable to extract magnesium metal from the Northwest magnesite ores: (a) chlorination of purified magnesia by heating with carbon and chlorine followed by electrolysis of the chloride; (b) direct electrothermal reduction by carbon followed by redistillation of the reduction product. The direct reduction of magnesia by carbon is particularly adapted to the treatment of high grade magnesite. There is every indication that this method may eventually produce magnesium at much lower cost than by the other methods."

These conclusions have been verified by recent developments. The West is following its pioneer tradition by adopting the new processes, which are better suited to its available raw materials. The Permanente Corporation has built the first unit of a plant to produce magnesium by electrothermal reduction of magnesia by carbon. It is now in the throes of the usual difficulties and delays to be expected when new techniques are being developed, but there is no reason to doubt that the project will soon be operating successfully.

Quite recently Basic Magnesium, Incorporated, received a Federal loan of $65,000,000 to build plants in Nevada which will use a method now in use in England and in Germany. Magnesia obtained from local ores will be chlorinated by heating with carbon and chlorine to produce anhydrous magnesium chloride which will be electrolyzed in the usual manner.

In the East, Dow Chemical is expanding its production of metal, and several new firms are entering the field. All of these will electrolyze magnesium chloride, but this salt will be obtained from new sources or by new methods. In its Freeport plant, Dow Chemical first precipitates magnesium hydrate from sea water and then converts it to the chloride. This is feasible because the byproducts of the alkali industry can be used to convert the magnesia content of calcined dolomite to $MgC1_2$ at low cost. Byproduct magnesium chloride from the potash industry is another favorable raw material.

Investigations Demonstrated That Electrothermic Processes Were Feasible

At Pullman, a laboratory investigation of the new methods over a two-year period demonstrated that electrothermal reduction of magnesia was feasible and had the most attractive economic possibilities. It also revealed that an industrial development would require the solution of many unusual

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and difficult technical problems. Therefore, a small pilot plant was designed and constructed to test the process and to develop equipment of a type suitable for industrial application.

Electrothermal Reduction by Carbon Involves Shock Cooling of the Metal Vapor

It is interesting to compare the reduction of zinc and magnesium oxides by carbon. In both instances the reactions produce carbon monoxide and the metal vapor. Zinc is reduced at 2,000 degrees F.; the vapor does not react with CO when cooled, and it is easily condensed as a liquid metal. The reduction of magnesia by carbon requires a temperature of 4,000 degrees F., and the reaction reverses when the gaseous products are cooled. Thus, the magnesium vapor will reoxide during condensation by ordinary methods, and it is impossible to obtain coherent metal by condensation in the presence of carbon monoxide.

However, if the metal vapor is instantly cooled from the reduction temperature (4,000 degrees F.) to about 350 degrees F., it will condense as a very fine metal powder. During this temperature range, chemical equilibrium would result in complete reoxidation of the metal by reversal of the reduction reaction. The amount of reoxidation is a function of the cooling time and may be limited to about 20 percent by effective methods. After the metal has been cooled, the reaction rate is negligible and subsequent reoxidation can be prevented.

Such a rapid condensation of magnesium vapor has been called "shock cooling." It can be accomplished effectively only by a very rapid and thorough dispersion of an adequate quantity of cooling medium in the vapor. Hence, the cooling medium should be a fluid or a fine powder and means for rapid dispersion must be provided.

The reduction and shock cooling are accomplished best as a continuous operation. A stoichiometric mixture of MgO and C is fed continuously into an electrically heated chamber. The reaction is highly endothermic and therefore, proceeds at a rate limited by the heat supplied to the furnace. The continuous and rapid evolution of the reduction products, Mg vapor and CO, create a pressure in the furnace that forces them at high velocity through an exit orifice and into the shock cooling chamber. The latter may be a nozzle or a flue, which should project through the furnace shell so that the magnesium vapor will encounter the cooling agent while it is still at the reduction temperature.

Shock Cooling May Be Accomplished by Various Agents

If the cooling agent is a gas, dispersion is readily accomplished merely by injecting it through orifices directly into the flue through which the magnesium vapor escapes from the furnace. A liquid or solid cooling agent requires an effective atomizing device to obtain rapid dispersion. The importance of rapid and thorough dispersion of the cooling agent can scarcely be overemphasized as a means of producing efficient operation. MgO has an exceptionally high heat of formation and the heat evolved by reoxidation is large compared to the heat of condensation. Reoxidation thus not only reduces the thermal efficiency of the operation, but it also increases the amount of cooling medium required for condensation.

The quantity and temperature of the cooling agent must be such that it can absorb the heat liberated by condensation of the metal and the heat of such reoxidation as may occur. In special cases the heat of fusion or vaporization, as well as the sensible heat of the cooling agent, can be utilized. In general, the cooling medium should be non-reactive toward magnesium. The metal has such an avid attraction for oxygen that no compound containing oxygen could be used as a cooling agent.

A Study Was Made of Cooling Mediums

Hydrogen was used as a cooling medium in the early development of the electrothermal process. Its high specific heat and mobility made it a very effective and easily applied cooling medium. About 2,000 cu. ft. of hydrogen is required to condense one pound of magnesium. Repeated use is necessary for economic reasons. Each time the hydrogen is used it picks up CO from the reduction reaction, and unless this impurity is removed it will eventually reach a reactive concentration. The cost of separating the carbon monoxide from such a large quantity of hydrogen represents a considerable proportion of the cost of the reduction process.

Natural gas is used as a cooling agent by the Permanente Corporation in the most recent industrial installation for electrothermal production of magnesium. In this case no attempt is made to separate carbon monoxide from the gas, because after serving as a cooling medium it is then used as a fuel in the nearby cement plant. Employed in this manner, it is undoubtedly a more economical cooling agent than hydrogen. Obviously this applies only where there is an adequate supply of the gas and also a subsequent use or market for it as a fuel.

Liquid hydrocarbons can also be used as cooling agents. Their effectiveness is greatly increased if all, or a major portion, of the liquid is vaporized during cooling, thus utilizing the heat of vaporization as well as the sensible heat. Any liquid that is not vaporized must necessarily be collected with the condensate. If only a small portion of the liquid evaporates, the condensate will be a dilute suspension of metal in the unvaporized liquid. This is very undesirable because the metal particles are exceedingly small (submicroscopic) and their separation from a large proportion of liquid is not economically feasible. The separation of the hydrocarbon vapors from the CO by condensation is relatively simple and inexpensive. However, the presence of enough oil in the condensate to form a thick but fluid suspension is desirable. It protects the pyrophoric metal from reoxidation, and the sludge can be collected and handled much more easily than the dry, pyrophoric powder. An extensive study of shock cooling with liquid hydrocarbons has been made at Pullman by the Bureau of Mines. The results obtained have been very satisfactory and the method is being developed and tested in a small pilot plant.

Condensate Must Be Redistilled or Sublimated

The condensate obtained by shock cooling magnesium vapor in the presence of CO is always impure. The metal powder is contaminated by the MgO and carbon produced by reoxidation as well as by such impurities as may have been present in the raw materials fed to the reduction furnace. Distillation or sublimation appears to be the only feasible means of obtaining coherent metal of high purity from the first impure condensate.

If the metal is distilled from a loose powder such as results from shock cooling by a gaseous agent, the condensed product will be contaminated by impurities transported as dust by the current of vapor. This can be prevented by briquetting or pelletizing the crude powder before redistillation. Compacting the loose powder is also necessary to provide adequate thermal conductivity during distillation. As the powder is violently pyrophoric, the

Pilot plant for the process developed at Pullman

collection, transportation, and briquetting must be done in an oxygen-free atmosphere.

If the crude condensate is collected as an oil sludge, the oil can be separated by a low temperature distillation which leaves a porous cake with enough coherence to prevent dusting when the metal is distilled later.

Apparently no one has attempted industrial distillation of magnesium metal at its boiling point, 2,021 degrees F. Suitable materials for a distillation unit to operate at this temperature are not available. Most of the methods by which magnesium has been refined go to the other extreme and sublime at low temperatures and pressures.

The simplest method is to place the briquetted material in a retort, apply a high vacuum, and heat the charge to about 1,300 degrees F. The metal sublimes at a very low rate and condenses as a beautiful crystalline ring in the cool upper part of the retort. This batch process yields metal of exceptional purity, but is thermally inefficient and requires more time, equipment, and labor than an automatic continuous distillation process. However, it was used by the American Magnesium Corporation to refine its electrolytic metal and has been installed in the first unit of the Permanente plant.

Efforts to carry out the distillation or sublimation of magnesium at low pressure as a continuous operation have encountered very difficult mechanical problems, and none of these efforts have yet been successful as an industrial process.

A continuous process can be carried out much more easily at normal pressure. This can be accomplished below the boiling point of the metal by circulating an atmosphere of hydrogen through the distillation system in order to transport metal vapor from the retort to the condenser. A practical rate of distillation can be obtained at 1,850 degrees F. in a current of hydrogen at atmospheric pressure. A retort constructed of high chromium nickel alloy will serve for such a purpose. The Bureau has successfully produced magnesium metal in its pilot plant by a continuous distillation process with automatic operations.

The Bureau Process Utilizes These Principles

The pilot plant, based upon extensive experiments on a smaller scale, operates as follows. Low grade magnesite ore, such as has been discarded in the selection of material for production of refractories, is concentrated by flotation to yield a product containing not less than 45 percent MgO, nor more than 1.5 percent SiO_2. This is calcined in a rotary kiln to remove CO_2 and produce a material containing not less than 90 percent MgO.

The calcine is mixed in a rod mill with 23 percent low-ash carbon. The mixture is fed into an arc furnace automatically at a controlled rate and reacts to form magnesium vapor and carbon monoxide. These products issue at high velocity through an orifice into the shock cooling flue where

(*Continued on page 47*)

WELD-FABRICATION OF MINE CARS

Mines are faced with the problem of increasing production at a time when sources of supply of new equipment are being affected more and more by scarcity of metals. This situation means that the mines must depend to a greater extent than heretofore upon the resources of their own shops in maintaining and adding to their mine equipment.

This article tells how mine cars are made, at the shops of the Cresson Consolidated company, in sufficient detail to serve as a guide to other companies who have the same situation.

CONSTRUCTION of mine cars comprises a good portion of the work of the welding department of the Cresson Consolidated Gold Mining and Milling Company of Cripple Creek, Colo. Now built by arc welding, the cars are produced in half the time required by the former method which consisted of a combination of wood and steel plate bolted together.

Capacity of a typical car is 16 cu. ft.—48 in. long by 24 in. wide by 24 in. deep. One end is hinged at the top and latched at the bottom to permit dumping as shown in Fig. 1. The whole body can be tipped as shown and rotated to any position. Construction is by the modern shielded arc process with equipment supplied by the Lincoln Electric Company.

The collection of parts used in construction of the mine car is shown in Fig. 2. All of these parts are made from standard stock mild steel—channels, flat and round bars and plates. These parts include (left to right, back to front): door straps, X-braces for axles, truck frames, "Fleetweld 5" electrode, bed arch, bumpers, door lever catch, wheel bearings, door hinge, fifth wheel turntable hinges, body hinges, door handle and door lever. Parts requiring bending or forming are made from standard stock, heated and forged in the blacksmith shop. These parts are continuously produced in the shop and are stored ready for assembly by the welders.

Body of the mine car is built from scrap plate—much of it old boiler plate with rivet holes as shown in Fig. 3, which also indicates the amount of plate used for one car. The welding shop has a bending brake which bends the sides and one end from one piece. The bottom is then welded to this bent piece. The third plate is the door which hinges as shown in Fig. 1. All of this plate is 3/16-in. The top rim and the sides are reinforced by 2-in. by ⅜-in. bar, welded on as shown in Fig. 1. This bar covers up the rivet holes of the scrap plate.

Shown in Fig. 4 is a mine car of riveted construction which required twice as many man-hours to build as the present welded steel car.

A truck frame fifth wheel assembly is shown in Fig. 5. Parts on the left are the lower part of the fifth wheel; those on the right are the upper.

Figure 1. Arc-welded mine car constructed by the Cresson Consol. Gold Mining and Milling Co., Colorado. Time of construction was only one-half of that required for former cars of riveted wood and steel plate

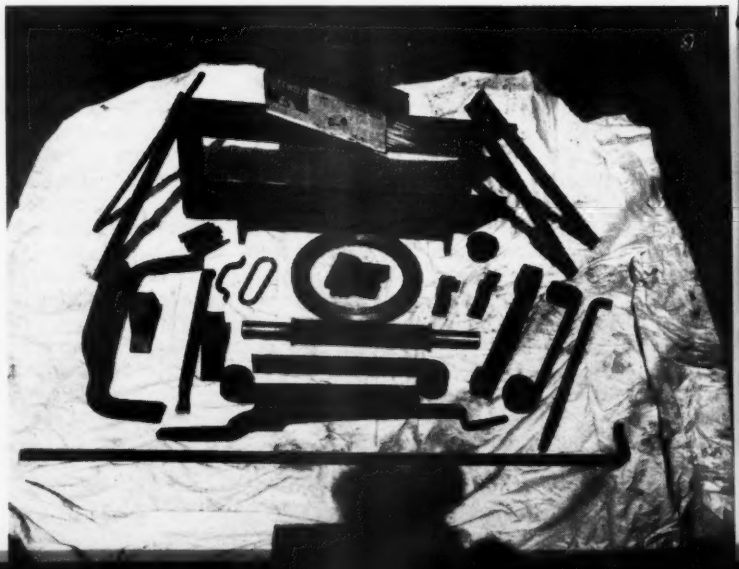


Figure 2. Right: Parts used in construction of car by arc-welding

Figure 3. Scrap plate used in body of an arc-welded mine car

Figure 4. Car formerly made of riveted wood and steel construction

The rings are rolled from bar stock and welded with a V-butt joint. The inner surface of the large ring and the outer surface of the small ring are machined to a fairly close fit, to permit easy turning of the one inside the other. The large ring is 12-in. diameter, the small one 10-in.—both built from 1-in. by 1-in. bars. The truck frame is built from one length of 5-in. channel with flanges veed at the bends, then welded. Length is 3 ft. 6 in. and width is 12 in. The axles are welded to the bottom of the frame and are braced by diagonals of 2⅜-in. by 2-in. bars.

Fig. 6 shows mine car body plate stored ready for assembly. This plate is scrap material—mostly old riveted boilers.

In Fig. 7, a welded steel mine car is shown in the ore house. These cars haul away the tailings which are hand picked as they pass by on a conveyor belt and are thrown into hoppers. The conveyor belt is on the floor above. These tailings are then dumped near by —used as fills for tracks and leveling off the mountainous mine property.

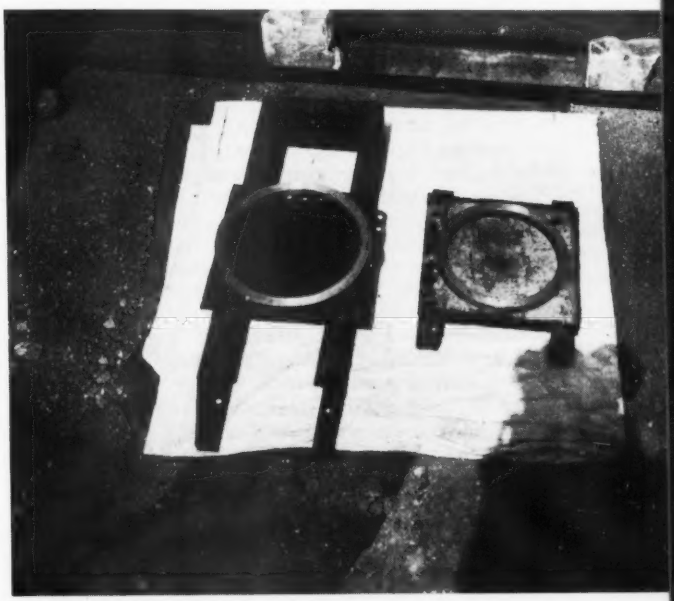


Figure 5. Arc-welded truck frame fifth-wheel assembly.

Figure 6. Supply of scrap plate for mine car bodies

Figure 7. Arc-welded car at the Cresson mine

VENTILATION SURVEYING

We have many problems in common with coal mine operators in other countries, in providing adequate ventilation, particularly as the mines become mechanized and standards of ventilation must be changed in the interests of greater safety and efficiency. This summary indicates the approach that our neighbors across the sea are making to these problems.

VENTILATION surveying is a subject which has been widely discussed in the last few years and round which an extensive literature has accumulated. Broadly it consists of making observations of the various factors connected with the ventilation system of a mine with a view to discovering any defects, suggesting remedies and estimating ventilation efficiency. The results of ventilation surveys are also helpful in the design and planning of new ventilation circuits and systems.

It is a well-known fact in mine ventilation, that as the air proceeds downstream round the ventilating circuit, there is a continual loss of ventilating pressure. This loss of pressure is not generally uniform with distance travelled by the air but depends upon the cross-sectional area, shape, alignment, and degree of roughness of the lining of the airways. There are two general methods of measuring pressure losses. These are (*a*) the barometer method and (*b*) the gauge and tube method. The barometer method employs sensitive aneroid barometers which require a high degree of skill in their manipulation. In the reduction of the results of barometer surveys many and varied corrections have to be made, some of which may be larger than the pressure drops which are to be determined. Conditions of steady surface barometric pressure are essential during the progress of a barometer survey. The main field for the barometer survey is the extensive survey carried out quickly, the results giving the main outlines of the ventilating pressure distribution.

For detailed and more accurate work the gauge and tube method is recommended. This method as generally adopted consists of connecting a gauge directly by tubes to the ends of the portion of airway over which the pressure drop is required. The pressure drop is then shown directly on the gauge. Thus an open roadway can be treated in exactly the same way as a cross cut containing doors. When dealing with an entire ventilation circuit extending from the bottom of the downcast to the bottom of the upcast, the full pressure drop is obtained by measuring short lengths of roadway in turn until the whole circuit has been traversed. The sum of these individual pressure drops gives the full pressure drop.

Abstracts of a Ventilation Report made by the General Research Committee of the Monmouthshire and South Wales Coal Owners Association.

Pressure Surveys Should Be Checked

In level workings the sum of the total pressure drops round a circuit from the bottom of the downcast to the bottom of the upcast at any instant, should be equal to the pit-bottom water gauge. This fact provides a rough check for the survey as we can take one value of the pit-bottom water gauge and check the sum of the pressure drops against it. The pit-bottom water gauge is influenced by surface temperature and when the latter varies through a wide range it is not always possible to get a good balance between pit-bottom water gauge and the sum of the pressure drops.

In steep workings natural pressures may be generated, and in order to effect a balance, the natural pressure must be added to, or subtracted from, the pit-bottom water gauge, depending upon whether it is working with or against the fan. In dip workings, natural ventilation generally assists, whereas in rise workings, the reverse is the case. The natural ventilating pressure may be calculated from the difference of level involved and the mean air densities in the intake and return.

The gauge and tube method is a relatively simple and rather slow process, it does not require high skill and could be carried out by the colliery staff. As soon as the ends of the section of airway are connected to the gauge the pressure drop is registered and can be instantly observed by the colliery official without any complicated calculations. While not having the portability of the aneroid it gives more accurate results and can be used for the detailed examination of localized obstructions such as bends, air crossings, etc.

Aneroid barometers may be read to about 0.01 in. of water and an inclined gauge set at approximately 1 in 10 may be read to about 0.001 in. of water. Hence pressure drops can be obtained with greater accuracy with the gauge and tube method than with the barometer. Pressure measurements made by the gauge and tube are not affected by changes in surface barometric pressure.

Air Quantity Surveys Are Also Important

The making of the necessary observations for the determination of the air quantity distribution in a ventilating circuit is usually spoken of as a quantity survey. Before the quantity flowing in any particular airway can be calculated, observations of air velocity and cross-sectional area must be made.

It is of the utmost importance when making a ventilation survey to make a large number of quantity observations and not just a few spot readings here and there. At all splits sufficient quantities should be measured to show that the air flowing to the junction is equal to that flowing away. Hence at least three determinations are required. No quantities should be found by measuring two flows and getting the third by difference, all should be measured in order to provide checks. This procedure should be carried out at all leakage points, and the leakage current measured by means of a dust test. A similar procedure should be adopted at the points where the air streams reassemble. Where there is a long length of roadway without splits, several determinations at intervals should be

made. In this way leakage through packs and strata can be detected. If there is no leakage the mean of these readings gives a very reliable quantity value due to the large number of observations taken. When placed on a plan of the mine the quantity survey should balance, the intakes and returns being in the correct relationship when due allowance is made for temperature, humidity and strata gas increases.

Leakage Is a Big Cost Factor

Quantity surveys can be extremely useful in bringing excessive leakage to the notice of the mine officials. Leakage is an extremely important factor in mine ventilation, far more important perhaps than is generally realized. It is without doubt one of the main causes of inefficiency in mine ventilation. The main losses caused by leakage are those due to the overloading of the main and trunk airways by useless flow. The power used in the actual leakage paths is very small and of little account but owing to the square law of the air flow, the added leakage quantities carried by the main airways force up the pressure loss and power requirements to a relatively large multiple of those which would be required for the useful flow only.

The prevention of leakage is a subject needing constant and close attention.

Procedure to Be Adopted in Ventilation Surveys

When making measurements of pressure loss, the portions of airway dealt with at each setting of the gauge should be carefully chosen, so that in effect, the circuit is divided up into a number of airway lengths or sections, such that each carries almost constant quantity for the whole of its length. The circuit then becomes a number of airways connected in series. This can be arranged by making all splits and points of leakage into measuring stations. For each of these constant quantity portions of roadway, at least one quantity measurement should be made. It is much better to make three or four quantity determinations in each separate section depending on the length of the section. The importance of making a large number of quantity measurements cannot be overstressed, as in a ventilation survey in which the gauge and tube method is employed it is found much more difficult to construct a quantity, than a pressure balance. Ventilation surveys are much more satisfactory if carried out when the mine is quiet although plenty of good work has been done on coal producing or turning shifts. However, it is possible in most cases to say when winding or hauling is in progress by noting the movement of the liquid in the gauge. In haulage roads of small cross sectional area it may be possible for a fast moving trip momentarily to reverse the air current by piston effect, but these effects are plainly shown on the gauge and observations should not be made until the liquid is steady.

The survey should begin at one of the pit bottoms, either the downcast or upcast, and proceed either with or against the air stream, depending on where a start is made, round to the other pit bottom.

Besides measuring pressure drops along the airway, advantage should be taken at all separation doors along the circuit, to measure the pressure across the intake and return. These figures can be used as checks in suitable circumstances.

A point worthy of attention in steep mines is that in inclined airways the true pressure drop will not be recorded on the gauge if the tubes are not full of air at the same temperature as that in the airway, hence in passing from intake to return, sufficient time should be allowed for the cold air to run out of the tube and be replaced by warm return air.

Comparison of the Flow Properties of Airways

It is very useful, especially from the point of view of ventilation planning, to be able to compare the flow properties of different airways.

This can be done most easily by calculating for each airway its resistance in Atkinsons, and then reducing all the lengths to some standard, such as 1,000 ft., thus giving comparative resistance values in Atkinsons per 1,000 ft.

As an aid to visualising the amount of resistance represented by one Atkinson it may be stated that 1,000 ft. of steel-arched roadway, 11 ft. diameter and 9 ft. high, offers a resistance of approximately one Atkinson. Also one Atkinson offers the same resistance as an equivalent orifice of 53 sq. ft.

Airways in Series and Parallel

Ventilation circuits are treated in pressure-quantity surveying as being made up of a number of airways connected end to end, or in series. Circuits will also contain a number of paths in parallel. The underground ventilation system as a whole will consist of a number of these circuits connected together in a series—parallel network. Hence ventilation calculations will deal mainly with these two types of groupings of airways: (*a*) those connected in series, and (*b*) those connected in parallel.

As one path at a time is traversed in a ventilation survey, the series case is the one most generally required and therefore, the unit giving the simplest series calculations, is the one most likely to be popular. Further, another common series calculation, is that of reducing the resistance or conductance figure to a basis of 1,000 ft. of airway.

It can be stated that the resistance in Atkinsons per 1,000 ft. of airway gives a figure for each airway which allows a ready comparison to be made of the flow properties possessed by each, irrespective of any pressure drop and quantity differences which may have existed in the airways when the observations were made.

Power Requirements for Ventilation

The power required to circulate a given quantity of air is proportional to the resistance of the circuit. Now the most economical ventilation system, provided the standard of ventilation is adequate of course, will be the one giving the lowest cost for power and construction and maintenance of airways. Hence there is a limit set by power costs above which it will be uneconomic to let airway resistance rise. The airways in which the power requirements are likely to be high are those which carry large quantities, such as the main and trunk airways. District airways, due to the reduced quantities are rarely large power users. Hence inbye airways may be of relatively high resistance and yet not absorb large amounts of power. Such airways may be suitable for transmitting small quantities of air but are uneconomical for large quantities. The power requirements of an airway, therefore, give some measure of its suitability for the particular task allotted to it.

Pressure loss per 1,000 ft. of airway also gives useful comparative figures showing in some degree the suitability of an airway for its task.

Reporting the Results of Ventilation Surveys

In reporting the results of ventilation surveys an attempt should be made to render defects as obvious as possible. To this end graphical methods should be applied as these allow a

true picture of the conditions to be made rapidly and easily.

The first and perhaps the most generally used method of mapping the results is to write the pressure drops, quantities and other relevant matter on a plan of the workings. In this way the ventilating pressure and quantity distribution can be shown in its true relation to the workings and airways. If some idea of the rate of the pressure drop in the airways is required, then each tenth of an inch of water gauge may be interpolated and marked by a tick. In this way portions of the circuit showing high and low rates of pressure drop become apparent by the close or wide spacing of the ticks.

When improvements in the flow conditions of airways are being discussed, information is sometimes required as to the whereabouts of the worst spots, so that these can be tackled first and the maximum benefit derived from any expenditure made. If the obstructions are localised they are readily shown on the graph, by the rapid increase in the losses. Where the resistance is spread over long lengths of airway, its location is not so obvious and a table of results can be calculated giving the p.d., a.h.p., and R values per 1,000 ft. of roadway, from these arithmetical values comparison is readily possible and the worst portions picked out. In doing this all three of the values should be taken into account together with the position the airways occupy in the circuit.

If ventilation surveying is practised several standards are open. For example in one case the standard mentioned was to maintain trunk roads of such a size as to give a maximum pressure drop of one-tenth of an inch of water per 1,000 ft. of roadway. In another case 0.3 in. of water was considered satisfactory. Another was to keep all main roads at a resistance less than 1 Atkinson per 1,000 ft. In other words the roads must be maintained either by area or by smoothing at a resistance less than that offered by a steel-arched roadway 11 ft. diameter and 9 ft. high.

Use of Air Velocities in the Control of Ventilation

A very simple and easily applied standard for use in the control of ventilation is that of velocity, and this is closely allied to the pressure drop standard. From the information at his disposal the mining engineer can fix the maximum velocity above which it is not wise to go. He may restrict his trunk airway velocities, for example, to 600 ft. per min. and sufficient cross sectional area of roadway will have to be maintained in order to keep below this figure. If a quantity increase is desired then this can only come, if the velocities are already up to 600 ft. per min. by increasing cross-sectional area. There are two ways of providing the latter; these are: (*a*) by enlargement of existing roads, and (*b*) by providing roads in parallel. Whichever of these methods is adopted is a matter of roadway economics. In very extensive systems the maximum velocity may be lower than 600 ft. per min., in others a higher velocity may meet the conditions. The velocity fixed will depend upon the conditions existing in the mine. To check the velocities and seek out the high velocity zones—once the maximum figure has been fixed, requires the use of an anemometer.

From the resistance per 1,000 ft. figures obtained for his own particular mine or mines, the mining engineer will be able to build up a picture of the resistances to be expected with the various types and sizes of supports used. For example, 12 ft. steel arching when newly set, closely strutted, and in correct shape may give a resistance of about half an Atkinson per 1,000 ft., but when crushed and distorted may offer a resistance of three to four Atkinsons per 1,000 ft. From his own intimate knowledge of conditions and costs as to road maintenance he will be able to build up a cross-sectional area-resistance relationship for roads enabling the correct size of road to be made in the required position. In only a few cases does the resistance per 1,000 ft. fall below one Atkinson. A general average in actual cases may be taken as from three to five Atkinsons per 1,000 ft. for the main roads. This figure is for straight unobstructed airways and appears to be rather high.

Air Horsepower per 1,000 Feet

Air horsepower losses for trunk airways, where relatively large quantities are flowing have an average of about 5 per 1,000 ft. This figure is rarely reached in the low resistance circuits where it would be considered excessive. In other more highly resistant circuits, much higher figures may be found and may still be economical depending on the factors involved. Lower values than 5 a. h. p. per 1,000 ft. are, in most cases, desirable and a suggested round figure, which should not be exceeded, is 3 a. h. p. per 1,000 ft.

Pressure Losses per 1,000 Feet

An average for pressure losses, is in the region of 0.4 in. of water per 1,000 ft. for main roads. This again might be considered excessive in some circumstances, but quite permissible in others. For the average large mine this figure is on the high side and should be brought down to 0.3 in. or less.

These suggested approximate maximum values of a. h. p. and pressure loss per 1,000 ft. will apply to most average mines, but the setting of standards is difficult owing to the variety of conditions.

Canadian Coal Field Developed

Canadian Collieries (Dunsmuir), Ltd., has announced the opening of the Timberland Basin coal field on Vancouver Island. The property was developed to some extent over ten years ago, and the workings, which underlie a conglomerate roof, have been dewatered and found in good condition.

Surface equipment will be secured from the Northfield Mine, which is expected to close operations in the near future. About 125 men will be employed.

The coal seam has been analyzed and checked for all characteristics and is understood to be of exceptionally good grade, though limited in extent.

Canadian Collieries has completed a modern briqueting plant at Union Bay, where a 3-ounce general purpose, high-heat briquet will be made.

Allaying Coal Dust

(*Continued from page* 17)

simpler construction; also it was more satisfactory to use the pump independently of the water box to avoid hauling the pump around with the box. A 1¼ in. x 10-ft. suction hose is used from the pump to the water box and a short piece of ½-in. hose is used from the relief valve to the water box.

Workmen are Enthusiastic About Results

The spray systems have been enthusiastically received by all workmen on the sections. Although a slight amount of extra work and care is caused by the installation of the sprays, the production has not suffered. It has been no job to sell the idea to the employes; in fact, they have taken unusually good care of the equipment and do not fail to report any interruptions in the spray systems.

Coal Convention Plans Become More Vitally Important

The demands of war, increasing the necessity for all-out production of coal, render the plans for the 19th Annual Coal Convention and Exposition of the American Mining Congress at Cincinnati, April 27-May 1, more important than ever. This meeting is the medium through which plans can be formulated for increasing production, for maintaining and obtaining the necessary equipment and supplies, for an interchange of ideas on new methods for greater and safer production, and for general discussion of the place of the industry in the war effort and the national problems which confront it.

The welfare of our country now demands that coal's modernization drive continue, and every type of mechanical aid to production will find increasing use. To the operators the convention will be the forum at which these matters will be discussed, to the end that workable solutions may be obtained. To the manufacturers this convention and exposition offers the most effective way to put across the story of new equipment, machines and supplies for coal production.

At the same time that there is a call for all-out coal production, there is the growing problem of substitute material. While coal mining is receiving consideration in priorities and allocation, the armed forces will undoubtedly take greater and greater amounts of the metals and materials which are ordinarily needed for production, and the industry will have to devise means of continuing the mechanization program and the maximum production of coal with a restricted amount of these materials. Maintenance and repair at the mine shops is also becoming increasingly important. Due to all these factors there is a greater need now for the free interchange of ideas on equipment and operating methods; the convention and exposition will meet this vital need of the industry.

The Program Committee, under the able chairmanship of J. Noble Snider, is now formulating a detailed program and is selecting specific subjects and speakers. Additionally, an able and public spirited group of men as chairmen and members of the various arrangements committees have accepted the responsibility of seeing that all arrangements for the convention are carried through to a successful conclusion. As shown on this page, the Arrangements Committee chairmen are as follows: Attendance Committee, Geo. F. Campbell, vice president, Old Ben Coal Corporation; Entertainment Committee, T. M. Googin, Westinghouse Electric and Manufacturing Company; Publicity Committee, H. H. Bullen, American Steel & Wire Company; Welcoming Committee, F. S. Pfahler, president, Superior Coal Company; Floor Committee, C. J. Potter, assistant to president, Rochester & Pittsburgh Coal Company; Miners' Exhibit Committee, G. E. Hoover, assistant engineer of coal properties, Chesapeake & Ohio Railway. These men with their committees will shortly take in hand the various services to the convention which this duty so cheerfully accepted entails.

On December 12, the Strip Mine section of the Program Committee met in Chicago under the leadership of Wm. L. Burt, chairman of the Strip Mine Committee and A. E. Marriott, chairman of the Program Committee for the West Central Section. Further plans were laid for two sessions on strip mining at the convention, to be held in a special meeting room in Music Hall, and recommendations were made that these be scheduled for Tuesday afternoon, April 28, and Wednesday afternoon, April 29.

Subjects for papers were selected as follows: Dragline Operations, Primary and in Tandem with Stripping Shovel; Power Distribution and Protective Power Devices; Drift Mining from Strip Pits; Shovel Tooth Design and Maintenance; and a Symposium, covvering developments in the West Central field, the Indiana-Illinois field, and the Ohio field.

These and other plans are now proceeding apace, in expectation of the important results to be expected from this most vital meeting of the coal mining industry.

ARRANGEMENTS COMMITTEE CHAIRMEN

GEO. F. CAMPBELL
Attendance

T. M. GOOGIN
Entertainment

H. H. BULLEN
Publicity

F. S. PFAHLER
Welcoming

C. J. POTTER
Floor

G. E. HOOVER
Miners' Exhibit

Open-cut iron orebody at Gold Star mine, Marinduque Island

TRANSPORTING ORE in the Philippine Islands

By W. F. BOERICKE
Chief Valuation Engineer
Philippine Bureau of Mines

Interesting and difficult problems in transportation have arisen in the development of mines in the Philippine Islands. Mr. Boericke, in the course of his work for the Philippine Government, has had an excellent opportunity to observe mine transportation practice in the Islands and he gives here an over-all picture of the situation.

Costs and distances are given in pesos and kilometers; to reduce these to dollars and miles, it should be remembered that a Philippine peso is equal to fifty cents, and that a kilometer is approximately six-tenths of a mile.

ORE and concentrates for shipment abroad from the Philippines are transported almost wholly by trucks from mine to point of ocean loading. Ore from mine to mill may be transported by aerial tram, as at the Davao Gold Mine in Mindanao or at Cal Horr Mine in Baguio. Occasionally, at some of the small coal and manganese mines, cargadores are employed to carry ore from the mine to the ore trucks, where the tonnage expected is too small to warrant the cost of road construction. Only a very low wage scale, of course, will permit this means of transportation. Yet during the early development period of the Hixbar Mine, now the second largest copper producer in the islands, as much as 60 tons of ore a day were carried down on men's backs over a steep trail from an elevation of 1,100 ft. to sea level, for a distance of 3 kilometers, by an army of cargadores. At the Batong Buhay Mine, located in an inaccessible part of Mountain Province, men and women cargadores were employed to bring in mine supplies and equipment before the road was built—which incidentally cost over ₱250,000 to construct for its 22 kilometers of length. These cargadores were paid 6 centavos per kilo, equivalent to ₱60 per metric ton. The average load carried over the trail, which in some places was very precipitous, was about 20 kilos, but some of the stronger men were able to take considerably more.

Transportation Is Principally by Trucks

Transportation of ore by animals in the Philippines is non-existent if one expects the few instances where caribaos (water buffalo) are used for short distances. Neither burros nor mules are seen in the islands, and the small native horses do not have the stamina for heavy work around the mines.

The motor truck is found at every mine and if any testimonials were required by American truck builders for ruggedness of construction and ability to stand up under the most gruelling of traffic conditions and lack of skilled maintenance and repair men, the Philippines can offer innumerable instances to gladden the hearts of sales managers. Ore trucks negotiate nearly impassable mountain roads in the rainy season that are choked with debris from slides after torrential rains; they are called upon to bring ore down river beds where there is no road at all; they push unconcernedly over a trail and make their own trackways through the undergrowth that springs up almost overnight. At the San Remigio

mine in Panay, some 10,000 tons of low grade copper ore were transported down a 20 percent mountain road to the Sibalom River, then for 4 kilometers along the rough stream bed filled with boulders before reaching the provincial road. The Hixbar copper mine now has a 4-kilometer road with a uniform 10 percent grade for the entire distance. Trucks of 2½-ton capacity move about 100 tons per day from mine to pier. The road is unsurfaced and exceedingly rough, as it is practically impossible to maintain any surfacing on so steep a grade for any length of time on account of the torrential rains that carry it all away. Trucks can travel only in low gear up and down the hill, and the ride either way is not recommended for quieting the nerves. Naturally the wear and tear on trucks enduring such service is very high.

Trucking Costs Compare Favorably with Costs Here

The cost of trucking ore generally is affected by the condition of the roads, the length of haul, regularity of shipments, and the capacity of the trucks employed. That is, a lower cost per ton-mile can reasonably be expected on a long haul with a large assured tonnage and trucks of maximum capacity. The individual elements that enter into cost comprise the cost of motor fuel and lubricating oils, the wages of drivers, cost of repair parts, wages of maintenance and repair men, tires, and depreciation. In the Philippines the cost of motor fuel, lubricants, tires, and repair parts is higher than in the United States, and because of war conditions, has shown steady increases. Wages for drivers and repair men of course are very much lower than in America. It might seem that trucking costs would be higher in the islands than in the United States under comparable conditions, but this does not appear to be the case. Some individual instances may be cited.

In Mountain Province the Lepanto Copper Mining Company formerly

Trucking manganese ore, Siquijor Island

contracted the trucking of its copper concentrates from the mine to the shipping point at San Fernando for ₱15 per ton, or about 9 centavos per ton-kilometer for the 163-kilometer haul. This was the more noteworthy as practically the entire distance was over the mountain trail, an improved road but subject to slides and encountering many heavy grades. Concentrates were shipped in drums, and at Baguio were transferred to larger trucks for the last lap of the journey. It is doubtful if this ₱15 rate could have yielded any profit to the contractor had he not been assured of some freight on the back haul. The total tonnage of concentrates hauled averaged about 1,200 tons per month.

Low Over-All Costs Are Achieved

At Bohol, the Anda Development Company which was engaged in mining manganese ore, shipped its product by trucks from Guindulman to Jagna, a distance of 25 kilometers, for the

Right, above and below: Road building to a coal mine, Zamboanga Province, Mindanao Island

Developing a mine camp, Mindanao

Native pier, Mindanao, chiefly for traffic in fish and coconuts

low rate of ₱1.35 per ton, or 5.5 centavos per ton-kilometer. About 150 tons per day were transported. This rate was possible only because of a first-class well-surfaced level road between the two points, but even at that it is doubtful if the contract was profitable.

On Siquijor Island, one of the principal sources of manganese in the Philippines, with a short haul of only 7 kilometers from the mines to the stockpiles at tidewater, the contract trucking rate was ₱1.25-₱2 per ton, depending upon local conditions, or an average of 23 centavos per ton-kilometer. About 100 tons per day were handled over fair roads with 6 percent grades.

In Paracale, the contract rate for hauling 75 tons per day for 4 kilometers from mine to mill is 75 centavos per ton or 18 centavos per ton-kilometer. For an 18-kilometer haul over an improved road, the rate is ₱2 per ton, or 11 centavos per ton-kilometer.

Large Quantities of Chromite Are Hauled by Trucks

At the Acoje mine in Zambales, the largest chromite operation in the Philippines, about 15,000-20,000 tons per month are trucked from the mine to the pier at tidewater, about 37 kilometers distant. A fleet of 150 trucks, each of 3½-4 tons capacity, is on the road. Much of the mountain road can only accommodate one-way traffic, hence only one trip per day can be made per truck. Grades are steep in places and although a large number of men are constantly employed on road maintenance and repair, it is no boulevard. No trucking by night is permitted until the road is further improved. The contract rate is ₱3 per ton, which includes unloading into the ore bins at the pier, and the cost per ton-kilometer is 8 centavos.

These contract rates appear to compare quite favorably with trucking costs in the United States, as gathered from Inf. Circ. 6898 of the United States Bureau of Mines, where the following estimate appears:

Distance Miles	Cost per ton-mile Average	Conversion to cost per ton-kilometer
Up to 1	$0.35	₱0.42
1-2	0.22	0.26
2-5	0.12	0.14
5-10	0.09	0.11
10-20	0.06	0.07
20-100	0.05	0.06

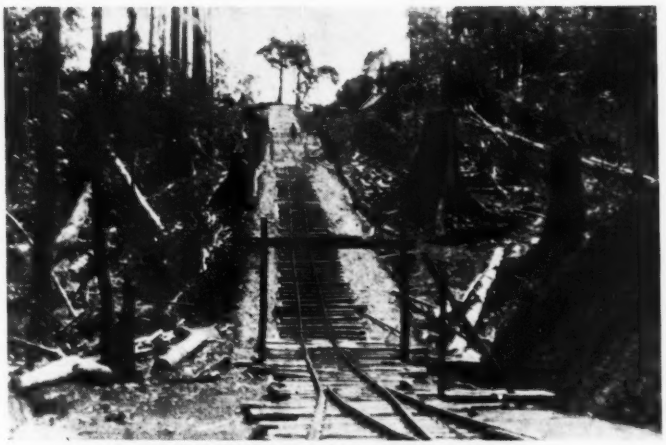
The most complete analysis of trucking costs that I have seen in the Philippines has been prepared by the engineers from the Gold Star Mining Company, which is one of the four

Transporting manganese ore from mine to aerial tram

principal iron ore producers of the Philippines, now closed down on account of export-control restrictions. This mine is located on the island of Marinduque, and is 21 kilometers distant from tidewater. Ore is transported from mine to pier by 12 3½-4-ton ore trucks of well known makes. These comprise both gasoline and diesel trucks. The gasoline trucks are being replaced by diesels as conditions permit, due to the greater operating economy of the latter.

Each truck averages eight round trips per 24 hours from mine to pier: thus each one travels 336 kilometers daily. The road is fairly good and quite well surfaced; there are no ex-

Bontoc women, northern Luzon, carrying mine supplies to Batong-Buhay mine



Gravity plane, coal mine development

cessively steep grades. Truck drivers work 12-hour shifts and are paid 7 centavos per ton delivered at the pier, thus their wage averages about ₱1.12 per shift. This may appear to be very low from an American standard, but as the usual wage for laborers in Marinduque is only 70 centavos per day, it is not out of line.

The normal output of the Gold Star Mine is 12,000 tons of ore per month. Good facilities are provided for loading and unloading the ore from the trucks.

Trucking cost figures for an average month (March, 1941) are as follows: (During this period the company operated 10 gasoline and 3 diesel trucks.)

Tons hauled (metric)	12,754
Number of trips	3,290
Tons per trip	3.9
Labor cost, total [1]	₱2,721
Labor cost per ton	0.214
Gasoline and diesel fuel	5.533
Gasoline and diesel fuel per ton	0.435
Lubricating oil	566
Lubricating oil per ton	0.045
Repair parts	1,442
Repair parts per ton	0.113
Tires	[2] 1,433
Tires per ton	0.112
Total cost, labor, fuel, etc.	12,695
Total cost, labor, fuel, etc., ton	0.918
Cost per ton-kilometer	0.043
Equivalent cost per ton-mile	$0.036

[1] The labor cost includes wages of drivers and repair men in the shop.

[2] Average cost, 7 months.

The above compilation does not include an allowance for truck depreciation.

Magnesium

(*Continued from page 37*)

they encounter an atomized spray of light fuel oil. Evaporation of a large part of the oil cools the furnace gas from 4,000 degrees F. to less than 350 degrees F. almost instantaneously.

The rate at which oil is supplied is so regulated that the unvaporized portion is just sufficient to form a fluid suspension of the metal condensate. This regulation is controlled automatically by the temperature of the cooled products. These comprise the finely divided solids, magnesium metal, magnesium oxide, carbon, silicides and carbides of the ore impurities; some liquid oil, oil vapor, carbon monoxide, and hydrogen and methane resulting from thermal dissociation of the oil.

The solid condensate and liquid oil are separated as a sludge from the oil vapor and gaseous products in a cyclonic separator of special design. The oil vapor is condensed afterward in a water cooled scrubber and the lighter fractions are recovered in refrigerated coils. The exit gas contains about 50 percent CO, 30 percent H_2, and 20 per cent CH_4. These have a fuel value about equal to that of the dissociated oil.

The sludge condensate flows by gravity from the separator and is pumped to the two-stage distillation furnace in which the oil and magnesium are separately recovered by distillation. The oil thus recovered, combined with the oil previously condensed in the scrubber, is recirculated through the spray nozzle.

The oil distillation unit includes a horizontal retort electrically heated to 930 degrees F. The sludge is conveyed through this retort in pans attached to a pair of chains. Oil vapors are swept from the retort to a water cooled condenser by a current of hydrogen circulated through the gas-tight system by a pump. Hydrogen lost through leakage is replenished by a slight cracking of the oil.

Removal of oil from the sludge leaves small, dry, porous cakes containing about 50 percent magnesium metal. These briquets drop out of the pans into a hopper from which they are fed into cages. The charged cages completely fill a horizontal alloy steel retort heated by electric resistors to 1,850 degrees F. The magnesium metal evaporates from the briquets, and the vapor is carried by a current of hydrogen to a condenser from which the molten metal is tapped.

The movement of the cages through the retort and their return to the feed end are accomplished by a ram and a drag chain mechanism, both of which operate outside the heated zone. Charging of the briquets, discharging of residues and all movements of the cages are accomplished automatically.

The reduction unit produces about 7 pounds of metal per hour with 75 KVA power input; 75 to 80 percent of the magnesia is converted to metal. A larger unit will undoubtedly be more efficient.

The recovery of oil and metal from the condensate is substantially complete in the distillation unit. The capacity of this unit is only 1 pound of metal per hour, and it is too small for efficient utilization of the heat input.

New Tipple Inspected

The new and modern tipple of the Page Coal & Coke Company recently put in operation at Pageton, W. Va., in the Pocahontas-Tug River District, was inspected upon completion by high officials of the company and affiliated interests. In addition to L. Rodman Page, president of the company, John J. Lincoln, vice president; Edward H. Evans, general manager; Archie T. Iddings, assistant general manager; and Edward C. Page, secretary-treasurer; the inspection party included Edward B. Leiseming, of the Stonega coal properties and the General Coal Company; Robert T. McCracken, director of the Crozer properties; Richard A. Ruff, assistant general manager of the Crozer and Upland Coal and Coke Companies; Robert A. Nowlin, chief engineer, Crozer Land Association; George E. Robinette, director of the Crozer properties in the Pocahontas Field; and Ralph H. Knode, of the Stonega Coal and Coke and General Coal Company.

Sunshine Mining Manganese

The Sunshine Mining Company is operating the Crescent mine on the Olympic Peninsula in Washington State, producing hausmannite, a manganese oxide. The U. S. Geological Survey reporting on this district said that future production will probably depend more upon the discovery and development of high grade hausmannite bodies rather than low grade manganese silicates.

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An Announcement of a Study on

BELT CONVEYORS FOR UNDERGROUND GATHERING

By CAREL ROBINSON

The Conveyor Committee has recently organized a Subcommittee on Gathering Belt Conveyors, which is under the chairmanship of Carel Robinson, Consulting Engineer. At their first meeting, in Pittsburgh, on November 21, this subcommittee formulated their preliminary plans, and this article explains the reason for undertaking the study and the general points which the report will cover.

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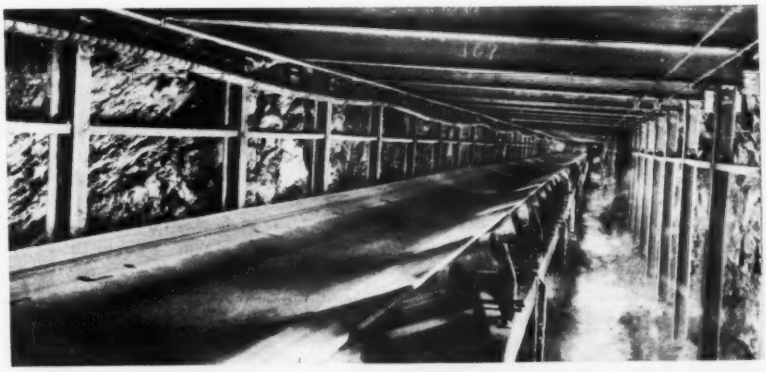
IT is estimated that there are at least 100,000 lineal ft. of belts used for conveying service in the coal mines of the United States, which, eliminating the return strands, would mean that there are 50,000 lineal ft. of belt conveyor lines in operation underground. This figure, in all probability, does not include slopes and tipple approaches, but refers strictly to gathering haulage installations in the working panels.

Regardless of the accuracy of this estimate, belt conveyors are becoming widely employed in coal mining, as service haulage units between the working faces and the main line car haulage; both for hand and mechanical loading. Like all other equipment, belts have certain advantages and disadvantages; they have been found suitable for some classes of service and unsuitable for other classes. Even so, there is a broad field where belt conveyors may be classed as competitive with other types and methods of equipment for gathering haulage.

The Coal Division Committee on Conveyor Mining is undertaking a study, based on the results of actual experience, in order to present data showing the operating and economic factors which determine the efficiency and economy of underground gathering haulage belts. It is believed a large amount of data are now available which can be correlated; main line belts several miles in length were installed in western Pennsylvania mines nearly 20 years ago and, while main line service will not be included in the committee's study, these operations developed a number of factors which have been applied to present practices. But in the early 1930's, gathering belts began to be used in connection with room conveyors, and in the subsequent installation of 50,000 ft. of lines mentioned many things have been learned that can be compiled into a report of practical value.

It is hardly necessary to state that these operations have met with varying degrees of success. Underground gathering belts are subjected to service not comparable to that of the usual surface installations—on coal tipples and in other industries—so it has naturally followed that there has been a considerable period of trial and error. This, by the way, is still the case, but certain specifications and methods of operation have been demonstrated as being either successful or otherwise. The committee therefore believes that a valuable service can be rendered to the coal industry by correlating and compiling the knowledge that has already been gained, with a view toward presenting certain fundamentals that should be taken into account by a company proposing to use gathering belt conveyors underground and, for that matter, observed by companies that now have belts in use.

A gathering belt conveyor in a mine has one basic difference from a tipple or other surface installation. A surface belt line is permanently located and is of a fixed length, while an underground gathering belt has a temporary location and, in addition, its length must be extended or shortened at fairly frequent intervals—sometimes weekly or daily. This immediately introduces new factors for which there is no guide from surface experiences; the supports must be of "knock-down" design and have the quality to withstand the abuse incidental to dismantling, transporting and resetting. They must be able to overcome difficulties of anchoring in



Permanent main line haulage belt

alignment due to changing grades and uneven floor. The facilities for changing the belt length must be suitable for quick installation, repeated fastening and unfastening, and the drive must perform efficiently under varying lengths and loads.

All of the above points were recognized or at least soon discovered in the early underground installations, and some little time elapsed before the designs were perfected to take care of these requirements. However, it then developed that this was merely the beginning of the story; the conveyors would run and would transport coal, but the questions of length, speed, carrying capacity, operating requirements and maintenance procedure were still to be answered before the real economies of gathering belts could be determined.

Like all other types of mining equipment, the economy of a gathering belt is measured by its cost in cents per ton of coal mined, and the committee will take three things into account—(1) investment charges; (2) operating cost; (3) maintenance cost. Each of these items depends upon the life of the belt and the total tons of coal carried, and requires a careful analysis before a determination can be made as to how conveyor transportation compares with other types of equipment.

The quality of materials and workmanship used in the manufacture of various parts of the installation will be given careful study. The idlers, bearings, pulleys and take-ups can vary widely from inexpensive to very costly; this also applies to the construction of the belt fabric and the character of the belt surface. Numerous examples are available where the failure of one or more of these items to conform to the service required, resulted in excess cost for replacement or correction; in certain instances very expensive material was not as satisfactory as cheaper construction.

A number of mines using belt conveyors have plans quite different from usual practices; and in any installation, some individual decisions are necessitated by the characteristics of the layout, the method of operation or the type of material to be handled. However, whatever these individual conditions may be, there are certain questions which have the same general answer for all mines, and the committee will endeavor to supply these answers, or at least will indicate how they can be found.

An important point to be investigated is the proper economical length of the conveyor line. Present installations vary from 200 or 300 ft. to as much as 2,000 ft. long, and there seems to be no rule as yet developed to determine what the practicable limit of length should be. For want of anything more definite, it can be stated that belt conveyors are working satisfactorily within the limits just mentioned, and, until some applicable formula has been determined, the decision as to the exact length in any specific operation would be governed by the mining projection best suited to work out a specified area. The length of the line and the carrying capacity directly affect the decision as to the type and construction of the belt, the type and the spacing of the idlers, as well as the size of the power unit, including motor, pulleys, speed reducers and the method of starting. All of these factors are inter-related.

The committee expects to investigate belt failures, which are known to result from a number of causes. The coal may vary from slack to heavy pieces with sharp corners and edges, but in any case, there is always the wear from straight abrasion. In addition, severe impact at the loading point may cause cuts and tears in the top

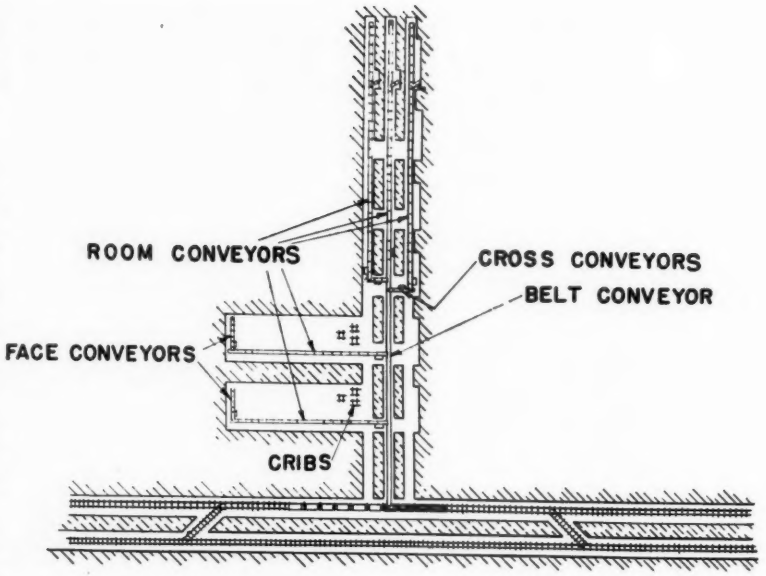


Figure 1. Entry development and rooms advancing

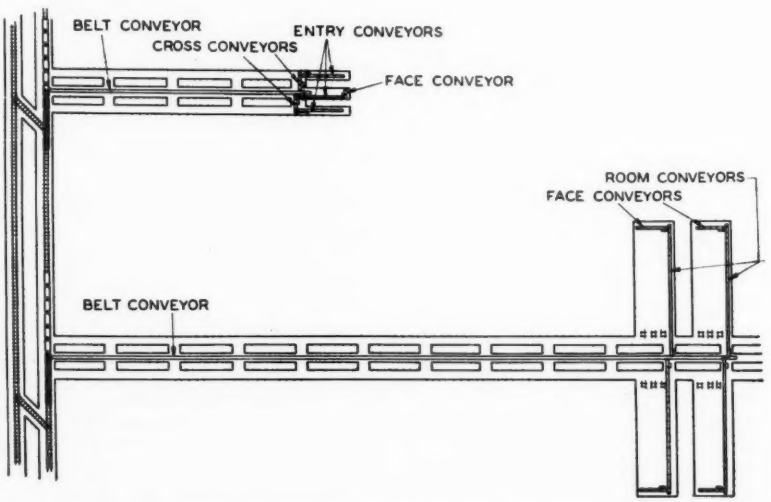


Figure 2. Entries developed for retreating rooms

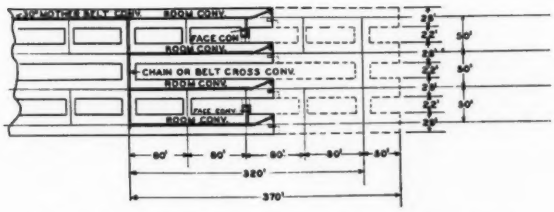


Figure 3. Four entry development for panel in Figure 4

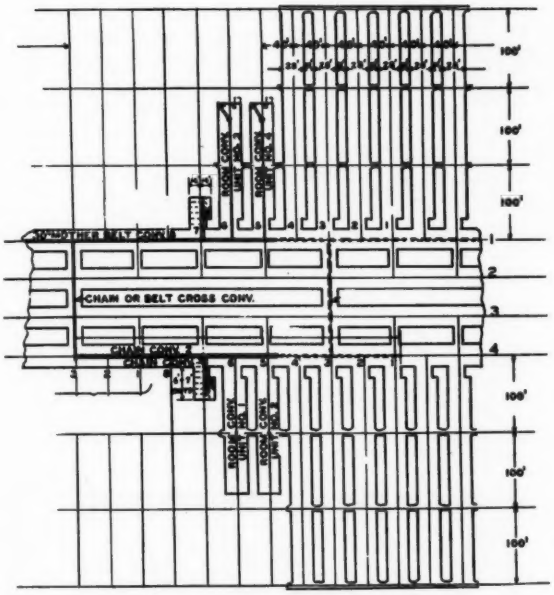


Figure 4. Double panel retreating system

Figure 1 might possibly be considered as a basic plan. In this operation, the belt is used for the entry development and also for a certain amount of advance room mining; the room mining is done to increase the coal tonnage, while the entries are being driven and while the belt is being extended to the panel limit. After the barrier has been reached, the number of rooms are increased on the advancing side and rooms on the opposite side are later mined retreating.

Figure 2 modifies the plan in Figure 1, in that the entries are developed as a separate operation, and after the panel limit is reached, the rooms are mined retreating off both sides of the entry. At that time, the headings in the next panel ahead are started and by close scheduling, the belt sections taken from the retreating room panel are moved ahead and used as the development entries are driven. This plan, however, requires two complete drives with motor, pulleys, takeups, etc.

Figure 3 is a plan of development for a retreating room system, in which a set of four room entries are driven to the panel limit. The entry conveyors, as the sketch shows, discharge onto a cross conveyor which in turn loads onto the 30-in. belt. The cross conveyor is moved ahead at 320 ft. intervals, and the belt conveyor is extended periodically as these moves occur.

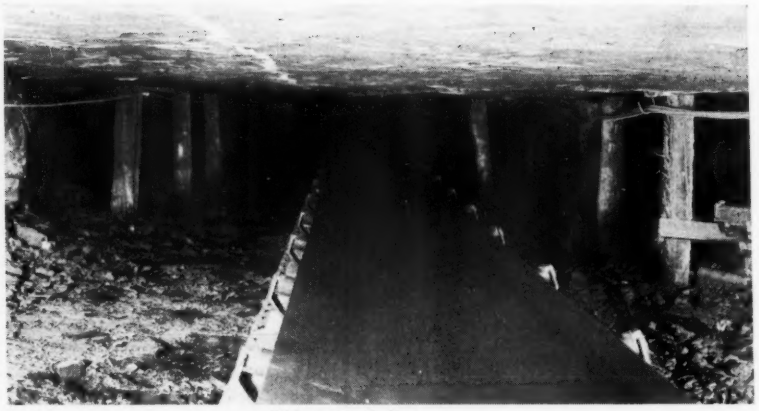
Figure 4 is a completion of the panel shown in Figure 3, and illustrates the method of working the rooms; these, as will be noted, are mined retreating and are worked to the right and left off the entries. As the rooms retreat, the cross conveyors are moved back at 320 ft. intervals and the belt conveyor is shortened accordingly.

cover; this might be corrected through proper design of the loading arrangement or by a change in the specifications of the belt cover. Then, there is also impact where the belt crosses the idlers and, if the sag is excessive, this impact is not only severe but is repeated many times throughout the belt line. Whether the correction should be made through increased belt strength to permit greater tension in the line, by closer spacing of the idlers, or by a decrease in the carrying capacity, are matters for attention by the committee.

Mining Plans

The general mining plan in which a belt conveyor is used, including the number of working places it serves, will have some effect on the specifications for the installation. The first step in the committee study, therefore, is to collect plans of conveyor operation; there are numerous variations in the arrangements that are now being used successfully, but the accompanying four sketches are submitted here as illustrating typical designs.

18-in. room gathering belt conveyor



30-in. entry belt conveyor

Outline of Committee Study

The committee report will be based on experience that has already been gained in belt conveyor operation, and the following list includes the points which are planned for study. It is of course understood that the complete report will require quite a little time to prepare and it is not the intention to start immediately on all of the items which are listed below; certain phases will be selected for first attention and subsequent studies will proceed in due order.

Factors governing length and speed.
Construction of belts.
Belt specifications.
Type of fasteners.
Method of installation.
Belt tension.
Reversing belt direction.

The power transmission system for a belt operation is the same as that required for other types of conveyors, and includes the proper switches for starting empty and loaded, and also fuses and other devices for protection against overloads, short circuits and power failures. These matters, however, are now being studied by the Power Committee. The usual maintenance, inspection and lubrication practices that have been found effective for all types of mining equipment apply equally to belt conveyors; one point, however, to which the committee may give attention is methods for the immediate repair of any cuts or abrasions that penetrate the belt surface into the fabric. Moisture, particularly acid moisture, will cause rapid deterioration with subsequent fabric breaks.

Operators and manufacturers will be asked to assist the committee by furnishing data on capacity, tonnage, character of coal, belt failures, method of maintenance, and records of accidents. In addition, special attention will be given to any innovations or "operating kinks" that have been developed.

Coal Mining Institute Meets

The 55th annual meeting of the Coal Mining Institute of America was held in Pittsburgh on December 11 and 12. The program included appointment of committees and election of new members. A feature of the meeting was the annual dinner on December 11, for which J. T. Ryan, Jr., was chairman of the arrangements committee. The principal speaker was Dr. R. R. Sayers, director of the U. S. Bureau of Mines, speaking on the subject of the Bureau of Mines and National Defense. At one of the sessions, a symposium was held, with W. Garfield Thomas, deputy secretary of Mines, Bituminous Division, Pennsylvania Department of Mines, as chairman, on "What are the hazards in connection with drilling and charging a number of holes with explosives before the coal is undercut or before the first shot is fired?" A second symposium, chairmanned by N. P. Rhinehart, chief, West Virginia Department of Mines, had as a subject "When should a mine be classed as gassy?" At other sessions, papers were presented by H. P. Greenwald, supervising engineer, Central Experiment Station, U. S. Bureau of Mines; Dan Harrington, chief of the Health and Safety Branch, Bureau of Mines; W. W. Dartnell, superintendent, W. J. Rainey Co., Bentleyville, Pa.; Jerome C. White, assistant chief engineer, Monroe Coal Mining Company; G. A. Shoemaker, general superintendent, Union Collieries Company; and J. A. Saxe, chief engineer, Island Creek Coal Company, Holden, W. Va.

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WHEELS of Government

● *As Viewed by A. W. Dickinson of the American Mining Congress*

THE hard fought congressional battle of November over the amendment to the Neutrality Act which permitted the mounting of naval guns on some twelve hundred ships of our Merchant Marine faded quickly into the background before the swift succession of events in early December.

Following the shock of the never-to-be-forgotten attack at Pearl Harbor early on Sunday morning, December 7, came the declaration of war against Japan on December 8 and the declarations of war against Germany and Italy on December 11. Although no doubt is felt in the United States over the ultimate outcome of the war, it is quite natural that the thought of mining men and metallurgists now turns to the status of our supplies of tin and tungsten, a very substantial portion of which has for many years come from the Far East. For the moment at least attention turns to South America and to the potentialities for greater domestic production of tungsten. It is a time for those who participated in removing the excess profits tax exemption for tungsten and other strategic metals to take counsel with their inner souls and consider the degree of embarrassment brought to our defense and now to our war program by that ill-considered action.

As is to be expected, also, these declarations of war have brought a change in the general situation, legislative and otherwise, on labor policies, price fixing, and in the anticipation of further revenue bills.

Washington Highlights

WAR ARRIVES: Capitol pitches in for Victory Program.

METALS CONTROL: War tightens metal use regulations.

LABOR CURBS: Sidetracked by Senate; labor-management conference convened by President.

PRICES: Rigid control probable, with wages excluded.

TAXATION: Hearings start mid-January on bill to raise additional billions.

PRIORITIES: Further consideration given mines' needs.

COAL MINE INSPECTION: Field work under way.

CAPTIVE MINES: Steelman awards UMWA closed shop.

EXPLOSIVES REGULATION: Bureau of Mines assumes war time control.

Remember Pearl Harbor

Eliminate Production Stoppages

The administration consent, secured as the price of amending the Neutrality Act, to permit the Congress, or at least the House of Representatives, to pass legislation curbing production stoppages in industry resulted in a surprise approval of the Howard W. Smith bill by a vote of 252 to 136 early in December. Embodied in the measure were provisions for secret strike votes supervised by the Federal Government in which all employes, whether union members or not, would participate; maintenance in plants of the status quo with reference to the closed or open shop; outlawing of mass picketing, as well as sympathy strikes and jurisdictional strikes; registration of labor unions, including filing of financial statements as to income and expenditures; due notice and staying of strikes for sixty days thereafter, pending mediation effort; and formalizing of the powers and statutory status of the Defense Mediation Board. The bill as passed by the House further prohibits communists, members of other subversive organizations, and criminals from holding offices in unions, and outlaws the importation of strike pickets. Penalties against violators include the loss of privileges under the Wagner and the Norris-LaGuardia Acts as well as of all federal bounties, including unemployment compensation and social security payments.

Immediately after House passage of the Smith bill, and before the declaration of war, it appeared that the Senate might take swift action, even to the point of substituting the Smith bill for the milder Connally or Ball measures pending on the Senate calendar. However, labor forces were immediately marshalled in Washington, and it is apparent now that this legislation is shelved for some time to come. Present plans call for a type of War Labor Board of industrial and labor leaders and officials of federal departments and agencies interested in labor matters. Such an arrangement would also carry a provision for a series of district boards functioning by industries throughout the country with the set purpose of maintaining the fullest possible production through the maximum practical number of hours per week.

These plans resulted from the management - labor - public conference called by the White House. This conference reached an "agreement" banning strikes and lock-outs for the duration of the war and to settle all labor disputes by peaceful means. The so-called agreement did not settle the closed shop issue but in his acceptance

letter President Roosevelt said that "all" disputes shall be settled by peaceful means, apparently signifying that disputes over extension of the closed shop will be carried to arbitration as was done in the captive coal mine strike. A determined bloc of Senators voiced their disapproval of this agreement and are insisting upon some form of labor legislation, particularly to freeze the status of closed and open shops during the war period.

What Price Control?

The Glass-Steagall Price Control Bill passed by the House on November 28 was the subject of hearings before the Senate Committee on Banking and Currency and is expected to be considered on the Senate floor in early January. While there is still no disposition to include any control of wages under the measure, Price Administrator Leon Henderson did testify to the possibility that federal agencies will have to pay as much as 17 or 18 cents a pound to bring forth copper from marginal properties. In the Glass-Steagall bill as it passed the House, section 2 (e) reads: "Whenever in the judgment of the Administrator it is necessary . . . to obtain the production of marginal or high-cost producers, he may, on behalf of the United States, without regard to the provisions of law requiring competitive bidding, buy, store or use, or sell at private or public sale, any commodity produced in the United States by any such producer, upon such terms as he deems necessary."

Recently there have been charges and counter-charges arising between Senator Truman's Investigating Committee and OPM sources concerning production and lack of production of lead, zinc and copper. It is very apparent that misinformation and supposition have played a large part in the picture, but it is greatly to be hoped that limitations placed upon mining enterprises by discriminatory excess profits taxation, wage-hour rulings, National Labor Relations Act restrictions and other obstructions may be removed or sensibly reduced.

Congress Hesitates on Taxes

Following his resistance to the request of the Treasury during November and early December that a further revenue bill be considered this fall, Chairman Robert Doughton of the Committee on Ways and Means has now announced that hearings will begin on a revenue measure on January 15. This announcement came after a meeting between Mr. Doughton, Chairman Walter George of the Senate Finance Committee, and Treasury Secretary Morgenthau on December 12.

It is to be expected that the Treasury will ask for at least $5 billion of additional revenue. In the writing of this proposed bill extreme care should be exercised, in view of our present shortages of strategic and other metal and mineral products, to make certain that unwise restrictions are not placed upon mining enterprises, where the courage of the individual and his willingness to take a risk against big odds have long been known to be the prime essentials in exploration for and production of the metals which are the backbone of our war program.

Senator Harry Flood Byrd's Non-Defense Expenditures Committee, foreseeing huge requests for war appropriations, issued a preliminary report recommending savings of $1,716 million in the next fiscal year. The report asked for curtailment of a wide range of relief, farm, public works and other "depression activities" and pointed out that further studies should bring about additional savings of from $1½ to $2 billion. This report proposed $1,301 million cuts in non-defense spending and asked legislation returning to the Treasury $415 million in unexpended balances which had been impounded by the budget bureau.

Mines Will Get Priorities

Effective December 2, the amended Preference Rating Order P-56, administered by the Mining Priorities Branch of OPM, was issued, giving an A-3 rating at the discretion of the Administrator on new mining machinery and equipment. An A-3 rating may be used directly by the mineral producers to secure repair parts and the A-8 rating continues for the procurement of current consumable supplies. Placer gold mines are still excepted from this order. For breakdowns the new P-56 order gives an A-1-a, and for reasonable provisions to avert breakdown, an A1-c. It has now been definitely decided in the OPM that mining priorities treatment will remain under the present Administrator, Dr. Wilbur A. Nelson, and it is the general feeling in the industry that this is a very fortunate situation.

During December three preference rating orders of interest to mining were issued by OPM Priorities Direc-

(*Continued on page 59*)

U.S.S. Arizona. Her loss will be avenged

OFFICIAL U. S. NAVY PHOTO

PERSONALS

W. V. DeCamp, general manager for M. Hochschild, owner of large tin producers in Bolivia, S. A., recently addressed a meeting at the Mackay School of Mines, Reno, Nev., speaking on the opportunities for mining engineers in Bolivia.

Harold Kinzie, representative of the Binkley Coal Company, has moved from Winona, Minn., to Omaha, Nebr.

A. V. Quine, formerly manager of the Cornucopia Gold Mines in Oregon, is now superintendent for Cinnabar Mines, Inc., at Prineville, Ore.

George C. Trevorrow has been appointed general superintendent of the coal department of the Duquesne Light Company, succeeding **C. W. Gibbs**, who has retired.

Arthur O. Hall is engineer in charge of a development of a chrome property west of Red Bluff, Calif., under the management of Wright, Dolbear & Co., San Francisco.

Oscar F. Tangel, metallurgical engineer, has joined the staff of Battelle Memorial Institute, Columbus, Ohio, and has been assigned to the division of materials beneficiation where investigations of coal preparation and ore concentration methods are being made.

John E. Graham, formerly president of Cosgrove Coal Company, and later associated as sales manager with the Empire Coal & Coke Co., has gone to Washington as an executive of the OPM.

H. DeWitt Smith, who has been working with the Metals Reserve Corporation in Washington, has resigned as a director of the Phelps Dodge Corp., in order to devote his full time to the Metals Reserve.

Bruce McDonell, formerly secretary of the California State Mining Board, is now developing a group of tungsten claims in Pershing County, Nev.

Adam L. Wesner, formerly associated with the U. S. Bureau of Mines at the station at Rolla, Mo., has joined the technical staff of Battelle Memorial Institute at Columbus, Ohio, and has been assigned to the division of materials beneficiation where investigations of coal laundering and ore dressing methods are in progress.

G. Plenna Belcher of Conoway, Va., was made secretary-treasurer of the recently chartered State Line Coal Co., Inc., with operations in Buchanan County, Va. **L. A. Elswick** of Praise, Ky., and **Bebble Belcher** of Mouth Card, Ky., were made directors.

Howard Kegley was elected president, and **Robert Linton**, vice president, of the Mining Association of the Southwest, at the recent annual meeting in Los Angeles. At the same time, **John Herman** was elected second vice president and **Victor J. Hayek** was made secretary-treasurer. Directors for the coming year are **W. C. Browning, H. Clifford Burton, M. J. Holmes, George I. Holmes, G. A. Joslin, Roy Moore, Russell Mumford, M. N. Shaw, J. Percy Hart, B. W. Holeman** and **H. W. Howe.**

Darius A. Thomas, president of the Montevallo Coal Mining Co., has been elected chairman of the Bituminous Coal Producers Board for District No. 13, with headquarters at Birmingham, Ala. He succeeds the late **H. S. Salmon.**

Sherwin F. Kelly, who has been travelling extensively in connection with geophysical investigations, has for some time been carrying on seismic work in Arkansas, investigating bauxite deposits.

A. G. Delaney has been appointed general superintendent of operations at Gadsden, Ala., for the Republic Steel Corporation. He was formerly assistant district manager.

Hugh B. Lee was elected president of the Coal Trade Association of Indiana at the recent annual meeting at Terre Haute.

Gordon H. Chambers, vice president of the Foote Mineral Company, Philadelphia, recently returned from a visit to Brazil, where he inspected the varied mining operations of that country.

S. C. Rundle is in charge of test drilling exploration for the International Smelting & Refining Company on copper claims in the Yerington district of Nevada.

L. C. Gunter was elected president and secretary of the Southern Appalachian Coal Operators Association at the last annual meeting. Other officers elected were **B. E. Cheely**, first vice president; **John W. Williams**, second vice president.

H. L. Garrity has been promoted by the Utah Copper Company at Bingham, Utah, from the position of assistant mine superintendent to mine superintendent. **L. F. Pett** at the same time was promoted from general hill foreman to general foreman; **V. S. Barlow** was advanced from general track foreman to general hill foreman; and **J. C. Landenberger, Jr.**, was made general track foreman.

G. P. Fitz of the Ajax Coal Company, has been reelected as president of the Hazard Coal Operators Association of Hazard County, Ky. Other officers elected were: vice president, **W. E. Pritchard**, Algoma Block Coal Co.; secretary-treasurer, **A. E. Silcott**; Hazard, Ky.; and assistant secretary, **Elizabeth Warren**, Hazard, Ky.

Robert L. Kidd, metallurgical engineer of Salt Lake City, has joined the staff of the South Dakota School of Mines at Rapid City, as assistant professor of mineral dressing.

John H. Legg has been appointed superintendent of the plant of the Aluminum Company of Canada at Wakefield, Que., where magnesia will be produced from brucitic limestone ore.

Ivor Massey, Richmond, Va., a director of the American Retail Coal Association and a past president of the National Retail Coal Merchants Association, is now in the Army Air Corps as commanding officer of Langley Field, Va.

E. N. Pennebaker, chief geologist for the Consolidated Coppermines Corporation at Kimberly, Nev., is at Matahambre, Cuba, continuing consulting work on which he has been engaged for the Minas de Matahambre.

H. A. Reed was recently elected vice president of the United Electric Coal Companies, Chicago, being promoted from his former position as chief engineer in charge of operations.

James R. Cady, former instructor in metallurgy at the Colorado School of Mines, resigned from that position recently to become foundry metallurgist for the Columbia Steel Co., at Pittsburg, Calif.

G. C. Bateman, metals controller for Canada, has been appointed a member of the Canada-United States Joint Economic and Defense Production Committee.

James G. Scrugham, member of the U. S. House of Representatives from Nevada, attended the ceremonies at Boulder City, Nev., in November, and closed the switch which started the new electrolytic manganese pilot plant of the U. S. Bureau of Mines.

William H. Lowe, formerly sales manager of Luzerne Anthracite, Inc., at Kingston, Pa., has been appointed sales representative for the Cleveland-Cliffs Iron Company in western New York state, with headquarters at Buffalo. **R. V. Shanklin, Jr.**, formerly with the Crystal Block Coal & Coke Co., Huntington, W. Va., has also been appointed sales representative for the Cleveland-Cliffs Company, with headquarters in Charlotte, N. C.

Eldridge M. Fowler is employed by the U. S. Vanadium Corporation at Bishop, Calif. He was formerly with the Walker Mining Co., at Walkermine, Calif.

D. E. Renshaw of the industrial engineering department of the Westinghouse Electric & Manufacturing Co., E. Pittsburgh, Pa., has been reappointed to the committee on industrial power application, American Institute of Electrical Engineers.

Frank Reed, vice president of Crerar Clinch Coal Co., recently returned to his company duties after being in Washington as Chairman of the American Retail Coal Association Priorities Committee.

J. G. Butler, who for many years has been head of the rail coal sales organization of the Cleveland-Cliffs Iron Co., at Cleveland, Ohio, has resigned to enter the coal business. He and **Robert Y. Moffat**, president of the Moffat Coal Co., have formed a partnership for the development of coal lands in Western Pennsylvania.

Charles E. Adams of New York City, Chairman of the Board of Air Reduction Co., Inc., and the United States Industrial Alcohol Co., has been appointed head of the Iron and Steel Branch of the OPM, replacing **Arthur D. Whiteside**, who recently resigned to resume his duties as president of Dunn & Bradstreet, Inc. Following the resignation of Mr. Whiteside, **A. I. Henderson** was acting chief of the branch until Mr. Adams was appointed.

James L. Leonard, manager of the Idaho-Leadville Co., was elected president of the Northwest Mining Association for the ensuing year, at the recent annual meeting of the association in Spokane. **James F. McCarthy, Jr.**, vice president of the Polaris Mining Co., was elected vice president, and **J. B. Haffner**, general manager of Bunker Hill & Sullivan Mining & Concentrating Co., was elected a director at the same meeting.

Howard Mellor has been appointed vice president of the Illinois Zinc Co., with offices in New York City.

J. A. Jeffries of the Illinois Terminal Railway System, St. Louis, has been elected president of the Illinois Mining Institute.

Luther W. Lennox, general superintendent of Benguet Consolidated Mining Co., Philippine Islands, and **David L. Forrester**, general superintendent of Davao Gold Mines in Mindanao, Philippine Islands, are in the United States on vacation.

David A. Uebelacker, former chief of the Nickel Branch of the OPM in Washington, has been named chief of the Copper Branch, replacing **John A. Church**. Mr. Church has been made senior consultant for the Copper Branch. **Louis Jordan**, formerly assistant chief of the Nickel Branch, has been made acting chief of that branch, pending the time when he will take up another defense post. **Howard C. Sykes**, formerly chief of the branch for mica, graphite, etc., has been made head of the Stockpile and Shipping Imports Branch, succeeding **Philo W. Parker**, who returns to private business. **Howard F. Wierum**, who has been assistant chief under Mr. Sykes, was promoted to the position vacated by the latter.

W. R. Storms, who recently returned from the Philippine Islands is now employed by the U. S. Bureau of Mines at Tucson, Ariz., in work connected with the investigation of strategic mineral resources.

W. L. Lyons, safety director of the Kingston-Pocahontas Coal Co., was elected president of Post No. 1 of the National Mine Rescue Association which met in Bluefield, W. Va., in November.

Roger W. Straus, who has been vice chairman of the American Smelting & Refining Company since spring of 1940, was elected president of that company at a recent meeting of the Board of Directors in New York. He succeeds the late **Simon Guggenheim**.

A. E. Southgate has been elected treasurer of the Philadelphia & Reading Co. & Iron Co., succeeding **John S. Edelman** who died recently. Mr. Southgate had been credit manager for the company for the past 12 years and he will continue to hold this position in addition to his new post.

George W. Roddewig of Beverly Hills, Calif., and formerly manager of mines in South America, is now in Washington, D. C., as consultant in the zinc section of the OPM.

W. A. Maxwell of Denver, was reelected to the presidency of the Colorado Fuel & Iron Corporation at a recent meeting of the board of directors, and **Arthur Roeder** of New York was reelected chairman of the board.

E. R. Goss, who has been with the Chicago Pneumatic Tool Co., for 12 years, has been made manager of the El Paso, Tex., branch office, succeeding **E. J. Coughlin**, who was killed in an automobile accident in October.

Burr Wheeler, vice president of the Chile Exploration Co., and the Andes Copper Co., both subsidiaries of the Anaconda Copper Mining Co., recently left the states for an inspection trip to the copper mines of the company in Chile.

Patrick J. Ryan, formerly manager for Eldorado Gold Mines, Ltd., is now supervising diamond drilling on the Gunflint Iron Range in Ontario for a syndicate of investors.

S. T. Nicholson has retired as president of the Vulcan Iron Works, Wilkes-Barre, Pa.

W. A. Snyder, Jr., is superintendent of the new plant of the U. S. Diatom Co., Rosamond, Calif., where operations were recently started on the processing of diatomacious earth, which the company produces in Nevada.

— *Obituaries* —

The mining industry feels keenly the loss of Senator **Alva B. Adams**, 66, of Colorado, who died in Washington, D. C., while engaged in senatorial duties.

John R. Clements, formerly with the Hollinger Consolidated Gold Mines at Timmins, Ont., and more recently a pilot officer in the R. C. A. F., has been reported killed on active service.

R. B. Short, formerly secretary-treasurer of the Houston Coal Companies, of Cincinnati, Ohio, died in Oklahoma City in November. He was 51 years old.

Thomas Leonard, 79, founder of the Rocky Mountain Fuel Co., died in Denver in early November. He retired from the management of the company in 1938.

A. D. Carlton, manager of the coal department of Cleveland-Cliffs Iron Co., Cleveland, Ohio, died in early December in Phoenix, Ariz. At the time of his death Mr. Carlton was also president of the American Coal Distributors Association.

O. M. Kuchs, for several years general manager of the Andes Copper Co., died recently.

W. J. Benny, president of the Algoma Coal & Coke Co., with operations at Algoma, W. Va., died in Philadelphia in the late fall.

James W. Gwinn, 53, secretary of the Idaho State Mining Association for the past nine years, died of a heart attack in Kellogg, Idaho.

Stanley R. Moore, 63, general manager of the Standard Silver & Lead Co.'s Jay Gould mine at Lincoln, Mont., died in Helena following a brief illness. He has for many years been prominently identified with the Mining Association of Montana.

NEWS and VIEWS

Metals from the Pacific Area

In a recent release the OPM summarized the position of the United States in regard to necessary supplies from the Pacific area. It was said that best known of these vital imports are tin and rubber, but they are by no means the only materials for which we look to this far corner of the world. Chromite, manganese and tungsten for hardening steel; kapok for making life preservers; graphite for lubricating the machines of modern war; mica for insulation; manila fiber for making rope; the tea that we drink, and pig bristles for brushes—these and countless other things required for our national welfare we intend to get from the Far East and the Pacific.

Tin is probably the most important of our Pacific imports, and the one hardest to replace. We consume more than 100,000 tons of tin a year, produce practically none. Singapore and the Netherlands Indies provide us with our supply.

Canned food, a staple of American life, for soldiers as well as civilians, uses most of the tin imports. While glass can be substituted to some extent, and studies have been made of the use of silver as a lining for cans, tin is the most practical.

We have a good stockpile of tin on hand in this country; we are building a smelter in Texas to refine Bolivian tin ore. Careful conservation of our supply and possible expansion of the Texas smelter will help us get through the emergency. Nevertheless, the best solution is to keep the Pacific sea lanes open.

Manganese, chromite and tungsten are also drawn from the Pacific area. If steel is the bone of modern warfare, these alloying elements are its marrow. They make tough, hard steel, the kind that is used for armor plate and for projectiles that will pierce armor. They make possible modern tanks and fighting ships, war planes and guns. We need these minerals, all of them we can get.

We can facilitate the manganese problem by increasing imports from Brazil, Cuba and South Africa, and by rapid expansion of domestic production from low-grade ores. Molybdenum, plentiful here, may be substituted for tungsten in many cases.

Approximately a third of our chromium supply comes from the Philippine Islands and New Caledonia, the remainder from Africa, Turkey and Cuba. This makes freedom of the seas in the Pacific all the more important.

Low-grade chromite deposits in the United States are now being worked, so that we can increase our domestic supply as much as possible. But we must keep the sea lanes open to get the chromite we require.

Japan's threat to the Burma Road is a direct threat to tungsten, for down it comes the bulk of our supply. Domestic production increased sharply in 1941, and South America also is producing tungsten in quantity. Nevertheless, we imported twice as much as we produce this year and we need all we can get. Priority control exercised by the Office of Production Management has resulted in an increased use of molybdenum alloy in place of tungsten, but for certain military uses, tungsten steel is the best. Molybdenum is produced in the United States in sufficient quantity to free us of any dependence on imports.

We depend upon Madagascar and Ceylon for graphite, particularly the higher grade. Deposits in Alabama, Texas and Pennsylvania, however, will serve the purpose in the emergency and loss of all imports of graphite would not seriously impair our military production.

Mica, particularly mica splittings, also are involved in the Pacific. We received 90 per cent of our present supplies of this vital material from India, the remainder from Madagascar. Mica splittings provide the insulation necessary for electrical equipment and we cannot do without it. While we have a goodly supply on hand, we do not have enough to be independent of imports. This is partly a question of training labor, however, as mica splitting is difficult and tedious work. We can learn to split mica in this country if we have to.

All of the world's supply of Manila fiber, from which rope is made, comes from the Philippines area. There is no substitute for it and nothing takes the place of rope where rope is needed.

While these are the most important materials we get from the Orient they are by no means all. Palm oil, for instance, is important for tin plating. We get it from the Netherland Indies, the Philippines and the other islands of the East Indies. Cocoanut oil, from which we make glycerin, comes from the same area.

Captive Mine Closed Shop Issue Settled

On Sunday, December 7, a far-reaching decision was made as to whether captive mines should operate under the closed shop. The three-man Arbitration Board appointed by President Roosevelt ruled that all miners in the captive mines should be required to join the U. M. W. A. John L. Lewis was one member of the arbitration board; the final vote was 2 to 1 for the closed shop, with Benjamin F. Fairless, president of the U. S. Steel Corporation, dissenting, and John R. Steelman, the third arbitrator, siding with Mr. Lewis. At almost the same time the decision was announced, it was pushed from men's thoughts by the far larger issues raised as Japanese bombs fell on Pearl Harbor on that day.

All the steel companies involved had already indicated that they would accept the decision made by the arbitrators. Dr. Steelman said that the Mediation Board, in its previous 9 to 2 decision against the United Mine Workers, had recommended against the union shops simply because the Board did not feel workers should be made to join the union through Government compulsion. The Arbitration panel, he maintained, was functioning independently of the government and was, therefore, in a position to make a decision based solely on the merits of the dispute.

Mr. Fairless, while he dissented from the final ruling, said:

"I do not agree with the decision of the majority of this Board of Arbitration and I have filed a dissenting opinion. That opinion speaks for itself. However, I want it understood that notwithstanding my dissent taken in my capacity as a member of this Board of Arbitration, the captive coal mining subsidiaries of the United States Steel Corporation, in accordance with their acceptance of arbitration in this matter, will make the decision here recommended by the majority of the Board effective in agreements with the United Mine Workers of America."

Annual Colorado Association Meeting

The annual convention of the Colorado Mining Association is to be held at Denver, Colo., on January 23 and 24. The convention is planned on lines entirely new and different from those of any prior meetings in Colorado. Contests in first aid and other mining endeavors will be a feature of the meetings, which are already famous for the silver banquets and sowbelly dinners.

Federal Mine Inspectors Receive Training

The accompanying photographs show a portion of the corps of Federal coal mine inspectors in the process of receiving a six-weeks' training course at the Pittsburgh, Pa., Central Experiment Station of the U. S. Bureau of Mines. The first group of 40 coal mine inspectors will go into the field after January 1 to inspect and investigate conditions and practices in the nation's coal mines and to make recommendations for improving health and safety practices. Chosen from Civil Service registers, each of the new inspectors has had at least five years practical experience in the mining of coal and they are all recognized as having the training or experience of practical mining engineers.

During the intensive training course at Pittsburgh in November and December, the first group of new inspectors reviewed mine safety practices under the direction of experienced Bureau of Mines mining engineers as instructors, studied the most modern and improved methods of detecting mine gases, made analyses of air and dust samples, reviewed the safety factors in electrical mining equipment, analyzed mine ventilation systems, and examined causes of roof falls and haulage accidents. They also received instruction regarding the writing of their official reports, and methods of procedure under governmental regulations.

The course included a five-day period of training in mine rescue methods and in the use of self-contained oxygen breathing apparatus, with the inspectors participating in typical mine rescue maneuvers.

A second group of coal mine inspectors were scheduled to begin training at Pittsburgh on January 5, and follow the other inspectors into the field within a few weeks.

The men of the first group who have already received training and who now have their field work under way are (with home address):

Above and below: Federal coal mine inspectors receive training

Senior Coal Mine Inspectors

Bradley, Ira P., Cresson, Pa.
Dodge, Charles H., Nemacolin, Pa.
Jack, Alexander, Cresson, Pa.
Lamb, Warren V., Republic, Pa.
Mechling, Monroe J., Powhatan, Ohio.

Coal Mine Inspectors

Arnold, Gerald O., Boncarbo, Colo.
Bradburn, John E., Bridgeville, Pa.
Franklin, Raymon K., Pottsville, Pa.
Griffith, Franklin E., Farmington, W. Va.
Kelly, Leon W., Sego, Utah.
Palmer, William S., Benham, Ky.
Simpson, Oscar V., Morgantown, W. Va.
Tibbals, Charles E., Dormont, Pittsburgh, Pa.
Toothman, Glenn J. R., Hepsibah, W. Va.
Weber, Charles F., Hazzard, Pa.
Westfield, James, Jr., Castlegate, Utah.

Associate Coal Mine Inspectors

Estep, Roy C., Powellton, W. Va.
Harrison, Thomas H., Johnstown, Pa.
Linkous, C. E., Hazard, Ky.
Maize, K. Noble, Pittsburgh, Pa.
Morgan, Edward A., Hanna, Wyo.
Mounts, Carl N., Pittsburgh, Pa.
Schrecengost, Harry A., Harwick, Pa.
Scully, T. Alvin, Troy, Ill.
Spragg, Clarence, Monongah, W. Va.
Yanity, Joseph B., Clune, Pa.

Assistant Coal Mine Inspectors

Arnold, Clarence W., Morehead, Ky.
Bradford, Robert D., Birmingham, Ala.
Burdelsky, Harry R., Pittsburgh, Pa.
Christensen, Edward L., Rock Springs, Wyo.
Colbert, George W., Albany, N. Y.
Furin, Frank J., Uniontown, Pa.
Hodgess, Edwin E., Harwick, Pa.
London, Walter, Grant Town, W. Va.
Null, Victor D., Shinnston, W. Va.
O'Neal, Thomas H., Fairfield, Ala.
Phillips, Ray O., Des Moines, Iowa
Plasky, Joseph J., Pottsville, Pa.
Thomas, Edward, Oliphant, Pa.
Wylam, Lawrence L., Indianola, Pa.

Philippine Minerals Stockpiled

Just before Japan attacked the United States, it was announced that stockpiles of strategic minerals, destined for the Metals Reserve Company, would be accumulated in the Philippine Islands until they could be transported to America. This was in accordance with the recommendations of Henry F. Grady, representative of the RFC, who had made an economic survey of the islands and who said that the federal loan agency would put into effect a purchase program for materials needed for American defense. In Manila, E. D. Hester, economic advisor to the United States high commissioner, was appointed representative of the RFC to supervise the operation of the project, and Charles A. Mitke was to be in charge of the technical work of stockpiling and assaying. Materials already under order included approximately 350,000 long tons of chrome ore, 40,000 long tons of manganese ore, and 6,000 short tons of copper in matte or blister.

Wheels of Government

(*Continued from page 54*)

tor Donald M. Nelson. A non-ferrous smelting order (P-73), covering maintenance, repairs and operating supplies, provides a basic A-3 rating with special ratings of A-1-a for emergency breakdowns or suspensions of operations, and A-1-c for necessary advance provision to prevent breakdowns or suspensions. The A-3 rating is extendable by suppliers to their purchasers of raw material. Producers desiring to use this order must obtain a serial number from the OPM.

The former general repair and maintenance order P-22 was revoked and replaced by P-100 which differs from the old order in that it is expanded to include operating supplies. The new order, like P-22, covers gold placer mines.

Preference Rating Order P-23 was replaced by P-56-a which is applicable to manufacturers of machinery and equipment for all types of mining, including non-metallics, whereas P-23 applied only to coal and metal mining. The new P-56-a order provides for an extendable A-3 rating and is designed to continue reasonable provision for forward buying of needed materials without requiring manufacturers to come under the "Production Requirements Plan." Manufacturers are required to fill in form PD-25-a, following which authorization will be granted to apply an A-3 rating to approved quantities of critical materials listed thereon.

Then There is Coal

Acting Coordinator of Solid Fuels Howard Gray will soon be given assistants to cover separate divisions for the transportation of bituminous coal, anthracite coal, and coke. Coincidentally with the resolution introduced by Senator Maloney, of Connecticut, authorizing his special committee which made the investigation of the alleged gasoline shortage to extend its activities to the solid fuels, has been approved by the Senate. While Senator Maloney is from fuel-conscious New England, it is not believed there is any particular significance in the extension of his investigating committee's authority other than that it will serve as a chastening influence in the case of any peculiar solid fuels gymnastics which might appear as a parallel to Mr. Ickes' gasoline scare.

Approximately 50 federal coal mine inspectors began their field work the first of January under the law passed in the spring of 1941, and after having been given a six-weeks' training course by the Bureau of Mines. An additional group starts training in January and, later, a third group will receive training, until the full quota of inspectors provided by the Coal Mine Inspection Law is placed throughout the country.

Overshadowed by news of the Japanese attack in the Pacific on December 7, the decision of the Steelman-Lewis-Fairless Arbitration Board in the captive mines controversy was favorable to the United Mine Workers. Little surprise was felt in the industry, because the pleased expressions of the miners' national executive board, when they were told of the personnel of the arbitration tribunal, were a matter of common knowledge to all.

PETER F. LOFTUS

Consulting Engineers

ENGINEERING AND ECONOMIC SURVEYS, ANALYSES AND REPORTS ON POWER APPLICATIONS AND POWER COST PROBLEMS OF THE COAL MINING INDUSTRY

Oliver Building Pittsburgh, Pa.

ELRECO 1892-1942 **Overhead Trolley Line Material**

Has been manufactured continuously for half-century and during this period we have kept pace with the requirements of the Mining Industry in their Mechanization Program. Among ELRECO recent developments are heavy duty line material devices as well as distribution type equipment such as FUSED JUNCTION BOXES which include the interlocking features so requisite for safety. For your convenience an ELRECO Authorized Agent or Distributor has been appointed in your territory.

ASHLAND, KY.
Ben Williamson & Co., Inc.

BECKLEY, W. VA.
Beckley Machine & Elec. Co.

BENTON, ILL.
W. M. Hales & Co.

BIRMINGHAM, ALA.
General Machinery Co., 1600 Second Ave. So.

BLUEFIELD, W. VA.
Bluefield Hardware Co.

CHARLESTON, W. VA.
Virginian Electric, Inc.

CHICAGO, ILL.
Goodman Mfg. Co.
W. M. Hales & Co., 605 W. 116th St.

CLYMER, PA.
Clymer Hardware Co.

COLUMBUS, OHIO
Sackett Electric Co.

DANVILLE, ILL.
W. M. Hales & Co.

DENVER, COLO.
Hendrie & Bolthoff Mfg. & Supply Co.

HAGERSTOWN, MD.
Tristate Elec. Supply Co.

HILLSBORO, ILL.
W. M. Hales & Co.

HUNTINGTON, W. VA.
Logan Hardware & Supply Co.

JOHNSTOWN, PA.
Penn Machine Co.

KNOXVILLE, TENN.
Tennessee Equipt. & Supply Co. P. O. Box 322

LOGAN, W. VA.
Logan Hardware & Supply Co.

LOTHAIR, KY.
Mine Service Co.

MADISONVILLE, KY.
T & T Supply Co.

MIDDLESBORO, KY.
Rogan & Rogan Co.

NORTON, VA.
Norton Hardware Co.

PITTSBURGH, PA.
Cooke Wilson Elec. Supply Co. Chatfield-Woods Bldg.
Jones Mining Equipment Co., 541 Wood St.
W. F. McCullough Factory Representative 405 Penn Avenue
Penn Machine Co., Union Trust Bldg.
Bertrand P. Tracy Co. Fulton, Page & Hopkins Sts.

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SALT LAKE CITY, UTAH
Daniel C. Frobes Co., Dooly Building

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Scranton Elec. Constr. Co.

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J. W. Watkins, 565 Skinner Building

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2900-18 Cormany Ave. Cincinnati, Ohio

Explosives Control in Effect

The declaration of a state of war made effective the Federal Explosives Act of October 6, 1917, which prohibits the manufacture, distribution, storage, use or possession of explosives, or the ingredients of explosives, unless a license has been obtained from the Director of the Bureau of Mines, it was announced by Dr. R. R. Sayers, Director of the Bureau. Exempted are explosives used by the Army and Navy.

A revised version of the 1917 Act was passed by both Houses of the present Congress, and the measure was sent to conference to iron out a minor difference between the House of Representatives and the Senate. In its essentials, however, it is similar to the original law.

Personnel to act as licensing offices for the Bureau now are being selected, forms are being printed, and all other preparations are being made to put the provisions of the law into operation immediately, Director Sayers advised Secretary of the Interior Harold L. Ickes.

The 1917 Act and the present bill are both designed to keep explosives or their ingredients, from getting into the hands of persons hostile or disloyal to the United States or who are judged not to be reliable or experienced in the use of explosives, and provide heavy penalties for violation of any of its provisions or of any rules or regulations promulgated thereunder by the Director of the Bureau of Mines with the approval of the Secretary of the Interior.

All manufacturers, vendors, purchasers, analysts, educators, inventors, investigators and foremen and other users, except workmen who obtain their explosives from licensed foremen must obtain a license under the terms of the law. As soon as application forms are available, the Director said, a public announcement to that effect will be made, and rules and regulations will be promulgated.

Explosives are defined in the law as "gunpowders, powders used for blasting, all forms of high explosives, blasting materials, fuses, detonators, and other detonating agents, smokeless powders, and any chemical compound or mechanical mixture that contains any oxidizing and combustible units, or other ingredients, in such proportions, quantities, or packing that ignition by fire, by friction, by concussion, by percussion, or by detonation of, or any part of the compound or mixture may cause such a sudden generation of highly heated gases that the resultant gaseous pressures are capable of producing destructive effects on contiguous objects, or of destroying life or limb." Small arms or shotgun cartridges are not included in the definition. The Act specifically exempts the manufacture, under the authority of the Government, of explosives for, and sale to or their possession by, the military or naval service of the United States.

The superintendent, foreman, or other duly authorized employes at a mine, quarry or other work, according to the Act, may when licensed to do so, sell or issue to any workman under him such an amount of explosives or ingredients as may be required by that workman in the performance of his duties. A person so selling or issuing explosives, however, is required to see that any unused explosives or ingredients are returned and that no explosives or ingredients are taken by the workman to any point not necessary to the carrying on of his duties.

Applicants for licenses or any licensee must furnish the Director of the Bureau information regarding himself and his business as far as such business relates to or is connected with explosives or ingredients. Each licensee also is required to keep a complete itemized and accurate record showing each person or firm to whom explosives are sold, given, bartered or otherwise disposed of.

Only citizens of the United States and citizens of nations that are at peace with this country are eligible to receive a license and the Director may, when he has reason to believe that any licensee is disloyal or hostile to the United States refuse to issue a license or may revoke any license that has been issued.

Idle Mines Reopened

The Hudson Coal Company of Wilkes-Barre, Pa., recently announced that its anthracite production would be increased by reopening the Boston Colliery of the company, as well as some other mines in the Loree Division. These mines have been closed since the latter part of 1931.

Screening Facts

Not Just Claims

PREPARATION and concentration plants throughout the Mining Industry all agree that their screening equipment is the heart of their plant and to produce profits, must function efficiently. Simplicity Gyrating Screens do fulfill this requirement. The best proof of this fact is that over 1300 operating plants, each having from one to forty-six Simplicity machines, are on our list of known users.

One large producer, operating 15 plants in five different states, purchased their first Simplicity screens in 1929, and up to December 1st, 1941, had purchased a total of 104 Simplicity Gyrating Screens. Twenty-two of these units were purchased during 1941, with the bulk of them going into two of their newest and largest plants. Their purchases have ranged from 2′ x 3′ singles to 5′ x 12′ triples. During twelve years of operating Simplicity screens under all conditions, their records show a remarkably low average yearly maintenance cost per machine.

For Screening Facts, ask your Simplicity Representative, or write for our descriptive bulletin.

Simplicity Engineering Company

DURAND, MICHIGAN

All-Steel Tipple

A new all-steel tipple, equipped with fire-fighting devices has been completed for the Schuyler Coal Corporation of Rushville, Ill., by the Link-Belt Company. The tipple cost approximately $100,000. A contract has also been placed by the company for the construction of a washery for stoker coal.

Northwest Mining Association Meeting

An outstanding session of the Northwest Mining Association, which was held for three days, December 4, 5, and 6, in Spokane, was the luncheon on December 5, at which Governor Arthur Langlie of Washington spoke. Dr. Harold Culver was chairman at the luncheon and Ed Davis, director of the Department of Conservation and Development, Olympia, also spoke.

Every hour was marked by something of interest or by some fine entertainment, and with an excellent schedule of entertainment for the women guests. The keynote sessions were:

The session on Thursday, December 4, at which Frank Lilly, head of the mines research bureau, spoke on "The Muddle of Metals"; the session Friday, at which Murray Head of the Ingersoll-Rand Company, described the "Use of Large Core Drilling for Exploration and Ventilation." C. A. Lambly also talked on the method of "Forging Detachable Bits at the Pend Oreille Mine" of which he is the general superintendent.

Rowland King, resident manager of the manganese division of the Sunshine Mining Company, Port Angeles, pictured "An Unusual Occurrence of Manganese Ore." H. A. Doerner of the Bureau of Mines, Pullman, and Ivan Block, chief of the market development section, Bonneville project, Portland, Ore., presented their subjects in refreshing ways. Bliss Moore presided.

L. L. Wartes of Walla Walla reported on the possibility of an iron industry in the northwest, and Dean Drucker of State College, Pullman, talked on "The Proposed Methods of Obtaining Electrolytic Manganese in the Northwest." Sheldon L. Glover of the state division of mines told about "The Clays of Washington, Occurrences and Uses and a Possible Source of Alumina." J. Richard Brown presided.

Other important speakers were Frank E. Woodside, manager of the B. C. Chamber of Mines, Vancouver, who reviewed mining in the province this year; Earl K. Nixon, director of the Oregon State Department of Geology and Mineral Industries, reporting on new disclosures; Dean Milnor Roberts of the University of Washington; Dean A. W. Fahrenwald of the School of Mines, University of Idaho; Carl J. Trauerman, secretary of the Mining Association of Montana, who reviewed 1941 progress in his state; and S. H. Lorrain, United States Bureau of Mines, Moscow, Idaho.

On Saturday James L. Leonard, incoming president of the Mining Association, was installed at a meeting of the mining bureau of the Chamber of Commerce and the Mining Association. Raymond P. Kelley, president of the chamber, was the speaker. In the afternoon, Donald A. Callahan, a vice president of the American Mining Congress, talked on "Current Mining Problems," followed by a floor discussion. The Resolutions Committee reported on that day also.

Mining Firms Get Charters

Two coal mining companies with headquarters in West Virginia were recently chartered by the state secretary. The Vincent Coal Company, operating in Marion County and bearing a capitalization of $5,000, and the York Coal Company, in the Clay District of Harrison County, were the two concerns.

Harlan Association Elects Officers

At the recent annual meeting of the Harlan County Coal Operators' Association, held at Harlan, Ky., Charles S. Guthrie, general manager of the Harlan Fuel Co., Yancey, Ky., was elected president; R. E. Lawson, general manager of the Cornett-Lewis Coal Co., Louellen, Ky., was elected vice president; and George S. Ward was reelected secretary.

New Mexico Miners to Meet

The New Mexico Miners and Prospectors Association will meet in their fourth annual convention at Albuquerque, on January 16 and 17. It was announced that various clinics would be held on questions interesting to mining men and on the subjects of metallurgy, mining, social security, insurance, safety, prospecting, geology and mining law. A feature of the meeting will be a ladies party at one hotel on the evening of January 16, while a stag party will be held at another. The highlight of the latter will be a wrestling match between two former Association presidents, Benjovsky and McDonough, with A. S. Walter, another former president, as referee.

More Magnesium Production

The Union Potash & Chemical Company, operating mines near Carlsbad, N. Mex., recently announced that contracts would be let for construction of a $4,000,000 unit for the production of magnesium. In addition to this plant to be erected near the mine, it was stated that the firm had entered into a contract with the United States Government for the erection of a $9,000,000 refining plant at Austin, Tex.

The raw materials for these plants will be the potassium magnesium sulphate now being rejected by the Union Company in their operations. From this, a magnesium concentrate will be made and shipped in liquid form to the refinery at Austin, where metallic magnesium will be recovered by the electrolytic process.

The new plant at the Carlsbad operations will require the employment of about 500 men on a permanent basis, according to reports.

Miners Learn Prospecting

Under the direction of the Colorado School of Mines, classes have been conducted this fall in the art of prospecting, at the office of the Cresson mine in Cripple Creek, Colo. About 75 men have been taking the course. The evening sessions of the class are three hours each and field work is done on Sunday. The courses presented are those giving the information most valuable to prospectors, such as the use of the Brunton compass, and elementary mining geology and mineralogy.

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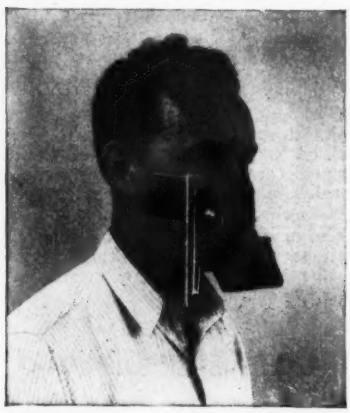
MANUFACTURERS' Forum

Dustfoe Respirator

A new and improved M. S. A. Single Filter Dustfoe Respirator has been announced by Mine Safety Appliances Company, Pittsburgh, Pa.

Featured improvement of the Dustfoe is the new Single Filter which replaces the two-part (felt screen and cellulose) filters used previously. This new filter is all in one piece, giving U. S. Bureau of Mines-approved pro-



tection against an even broader range of dusts and mists, states the manufacturer. The filter is more porous on the outer side so that the larger dust particles are filtered out first, thus preventing rapid build-up of breathing resistance through clogging of filter.

Other well-known features of the M. S. A. Dustfoe Respirator are retained. A protective filter cover prevents contamination of filter by grease and dirt from hands and equipment. A foolproof exhalation valve—leakproof Army Gas Mask Type—provides drainage. The formable facepiece of the Dustfoe may be shaped to fit individual face contours.

37 Millimeter Shot

The old Savannah Avenue plant (21,000 square feet) in Canton, Ohio—long in disuse—has been revitalized by the Timken Roller Bearing Company for the exclusive purpose of manufacturing 37 mm. shot.

There are two shells that will go a long way to win this war, and thus will be made in almost limitless quantities. These are the 20 mm. and 37 mm. shells. The Timken Company, in spite of its overtaxed facilities in the production of tapered roller bearings for national defense, is now making the 37 mm. shot and will undoubtedly, in the near future, start production on the 20 mm.

The 37 mm. is a one-piece armor piercing shot. S.A.E. 4150 modified steel bar stock is used. The steel is produced in the company's own mill. It is heated, preparatory to hardening, in an atmospheric controlled furnace, quenched in oil and air tempered. The 1 1/16-in. bar stock is machined on multiple spindle, 2 5/8-in. automatics, having a finished weight of 1.91 pounds. Exact inspection is required to come within weight tolerances specified. Banding is done by a cold swaging method, and then turned to size. The shot is painted externally with the exception of the rotating band. Machinery is being set up to produce 15,000 of the 37 mm. shot per day.

Illinois Coal Company Starts 30-Yard Electric Shovel

A 30-yard electric shovel, as large as any now in use, was recently put into operation at Cuba (Ill.) strip mine property of the United Electric Coal Companies.

Two Westinghouse motors, each having a nominal continuous rating of 250 horsepower, 230 volts, 410 r.p.m., operate the counterbalanced hoist motion. They are of the mill type of construction, with enclosed cast steel frames, and are forced ventilated to maintain a continuous flow of ventilating air throughout the operating cycle.

The powerful crowd motion which holds the dipper into the bank during digging and extends or withdraws the digger handle as required during the shovel loading and dumping cycle is driven by a forced-ventilated, mill-type motor with a nominal continuous rating of 125 horsepower, 230 volts, and 475 r.p.m. Two similarly designed motors, but arranged for vertical mounting on top of the gear case, operate the swing motion.

Supplying variable-voltage power to the three main motions of the shovel is a motor generator set composed of two 225 kw. hoist generators, two 112.5-kw. swing generators, one 112.5-kw. crowd generator, and a 35-kw., 125-volt exciter all driven by a 1,000-horsepower synchronous motor.

Easy and accurate control of the powerful main motions of the shovel is obtained from the three free-working type S.M. master switches mounted in the operator's cab. The hoist and crowd master switches have vertical handles, the swing is operated by foot pedals, and a thumb operated switch in the crowd master controls the dipper trip motor.

Electric shovel of United Electric Coal Companies

Stoker Division Moves to New York

Link-Belt Company, Eastern Stoker Division, has announced the removal of its sales offices, effective January 5, 1942, from Philadelphia to the Graybar Building, 420 Lexington Avenue, New York City. K. C. Ellsworth is in charge.

First Aid Kit

A completely weatherproof first aid kit, known as the Bullard Weatherproof, manufactured by E. D. Bullard Company, San Francisco, Calif., is now available with a mounting bracket that permits the kit to be removed instantly and carried to the injured when necessary. It mounts to the wall or post in such a way that when the lid is opened it acts as a shelf for the treatments being used.

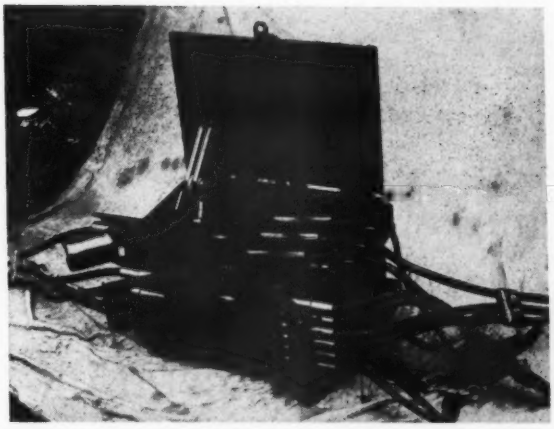
Contents are protected from the weather by a special "weather-strip" rubber tube that also acts as a spring that opens the lid when the fastener is released. Contents are easily removed whether the kit is laying flat or wall mounted because the sides are lower than the individual packets of treatments, which furnishes plenty of finger room.

Inside the lid of each kit is furnished an "Instant Guide to First Aid" which gives the user application instructions and injury diagnosis symptoms.

Improved Arc Welder Control

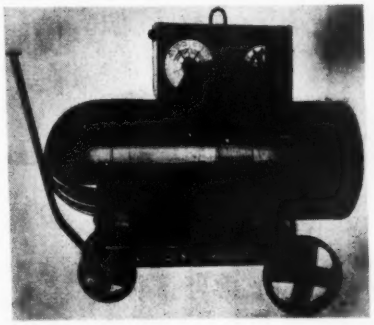
Improved and simplified design of its exclusive system of "Dual Continuous Control" for arc welding machines which eliminates the need for meters showing volts and amperes is announced by the Lincoln Electric Company, Cleveland, Ohio.

Standard Junction Boxes



The adjoining illustration shows the No. 1212 standard junction box developed by the Electric Railway Equipment Co., Cincinnati, Ohio. An outstanding feature of this junction box is that neither the negative nor safety ground connection enter the box; this leaves the entire interior of the box free for the positive circuits and fuses, and provides additional creepage surface, as well as lessening the tendency for leakage between the polarities.

This new welding facility has been in engineering design development and preliminary production line-up for some time and is said to be



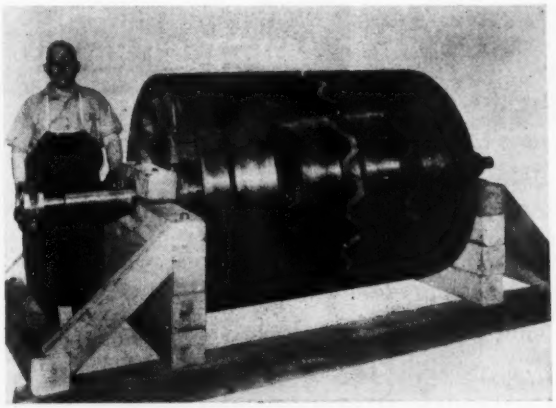
achieved as a result of the accuracy possible in current adjustments with "Dual Continuous Control" in conjunction with Lincoln's self-indicating pre-set dials.

These welders have both job selector and current control calibrated and equipped with dials which indicate the type of work and the number of amperes for each and every setting. It is claimed that this feature enables the welding operator to secure highest quality welds and highest possible welding speeds because he can vary both the slope of the volt-ampere curve and the amount of welding current independently and positively to suit every job encountered.

Classroom Lectures in A-C Training Course

A new phase in the training program for 140 graduate engineers at the Allis-Chalmers Manufacturing Co. was recently announced by the company. The two-year program for graduate engineers, who come from engineering colleges throughout the nation, has been expanded to include classroom instruction four hours a week. The classes will run 36 weeks a year.

The lectures and instruction are to be given by Allis-Chalmers executives, department managers, chief engineers, superintendents and supervisors. The classroom work, to supplement actual experience in the shops and other departments, will be divided into four basic subjects: psychology applied to business, basic sales methods, company organization and policy, and the engineering of Allis-Chalmers products.



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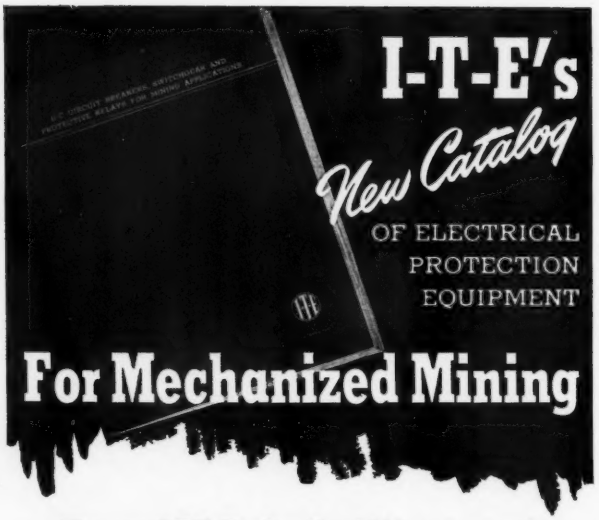

The new I-T-E Catalog No. 2502 is a complete description of d-c circuit breakers, switchgear and protective relays for mining applications. Its completeness recommends it particularly to those who are engaged in or contemplating mechanized mining.

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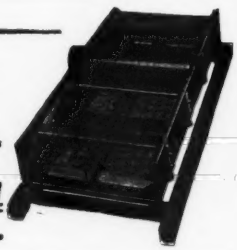

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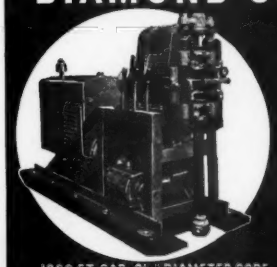

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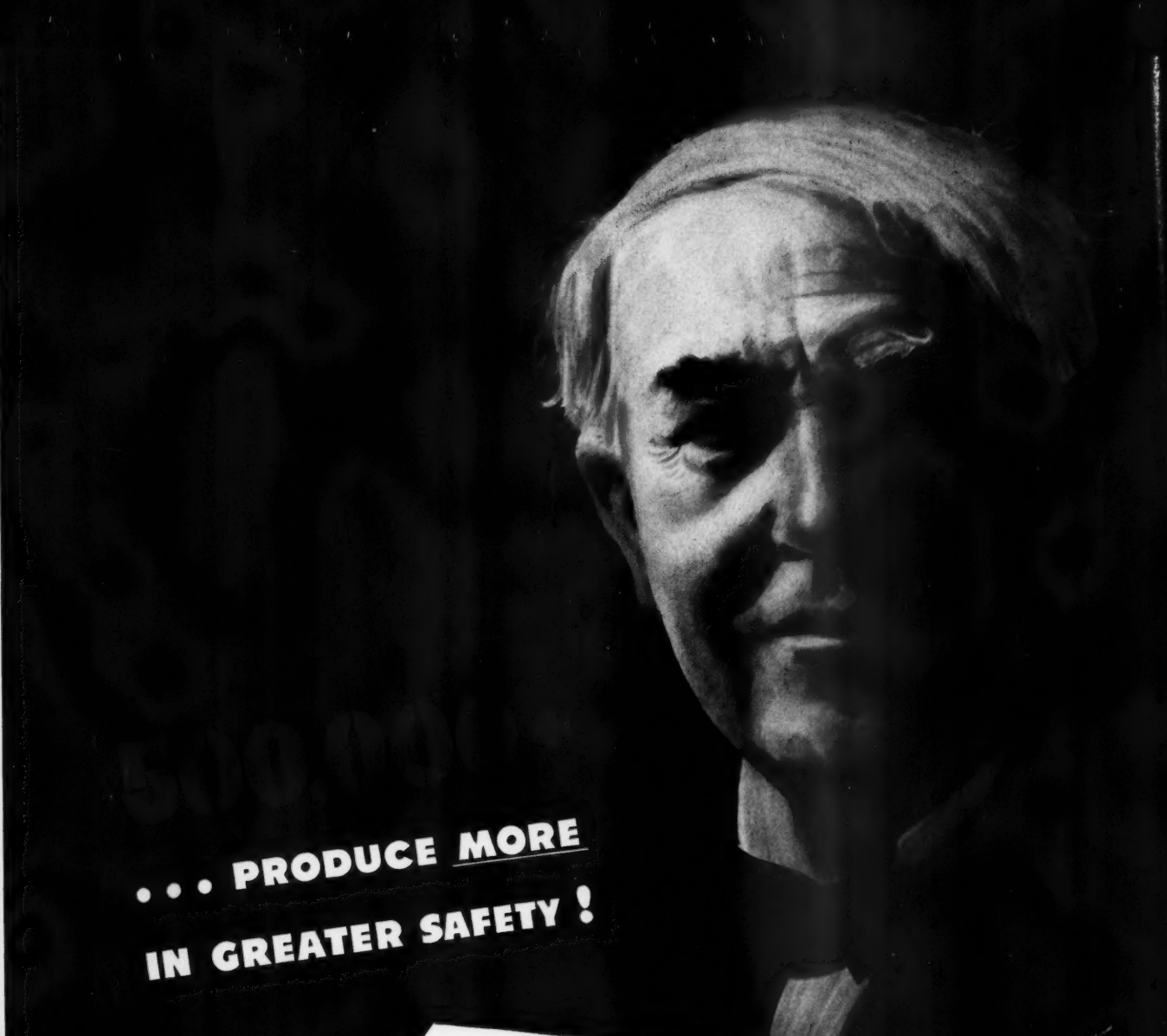

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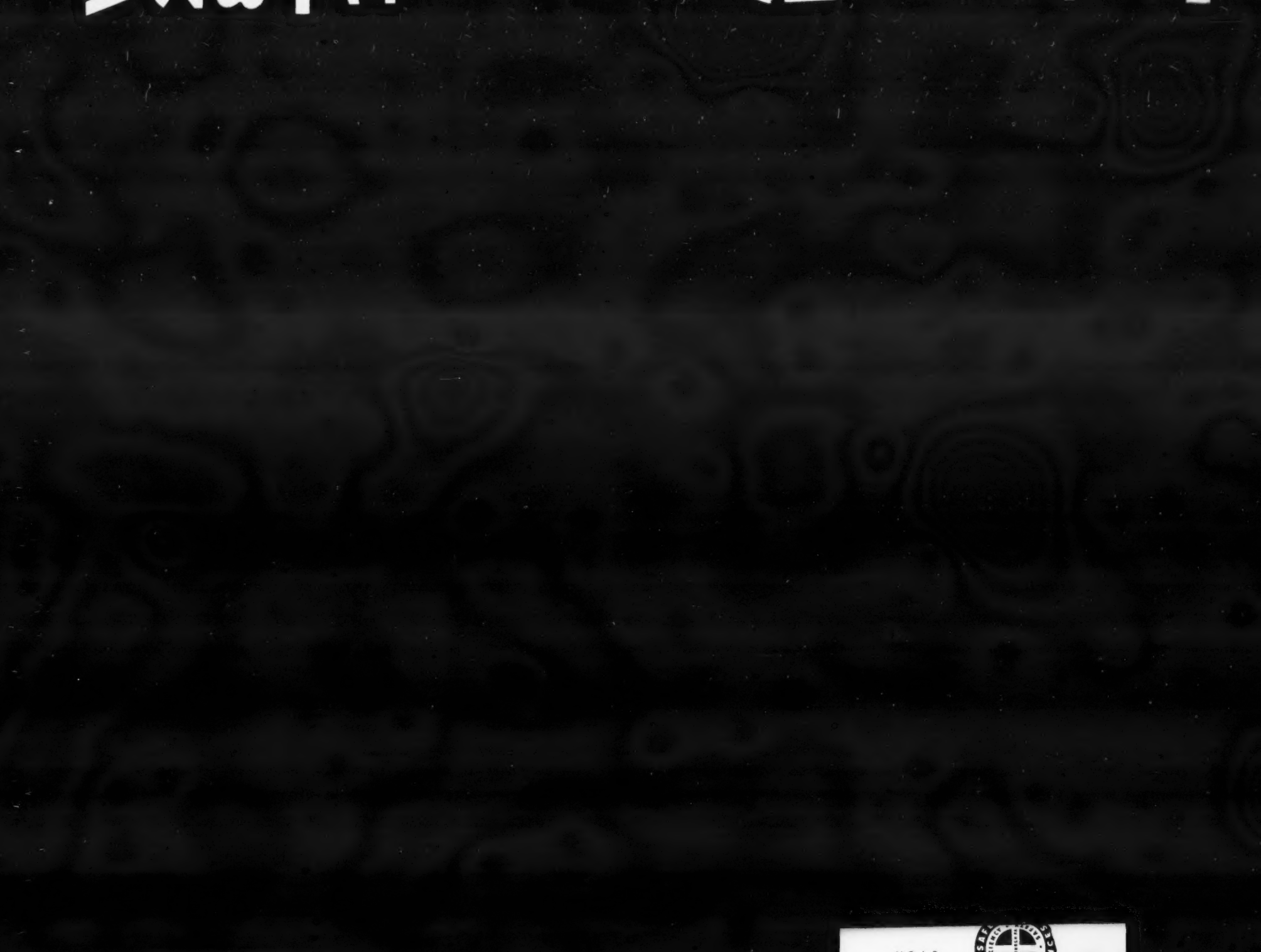
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